Preview

Australian Society of Exploration Geophysicists

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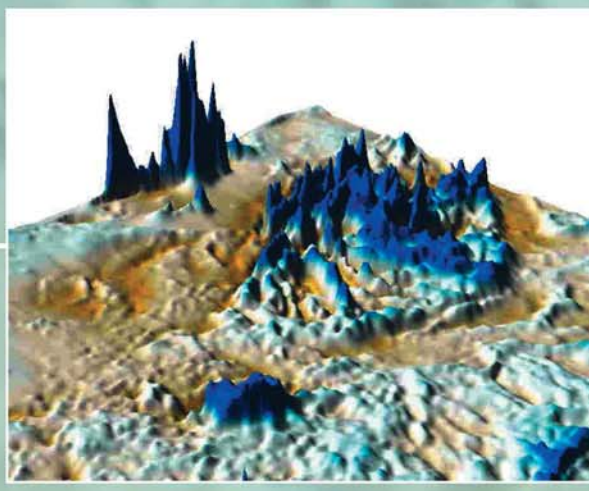

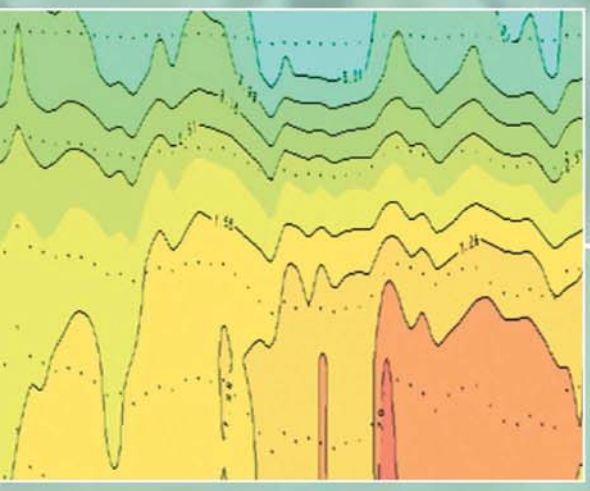

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David Denham

In this issue

Once again we have an interesting range of contributions to finish with for 2003.

Geoscience Information is a prominent theme, with an article by Paul Trezise of Geoscience Australia, and the launching of the new GADDS system described by Murray Richardson. I can commend GADDS, and strongly recommend that members log on and try it. It is a very important advance in making pre-competitive geoscience information readily available.

We then have articles on Acid Sulphate Soils, Hot Dry Rocks and a new satellite source for topographic information. So there should be something for everybody. I can also commend the WebWave sites reviewed by Margarita Norvill. Natural hazards are always of interest and the sites identified in this issue are well worth visiting; in particular the CBS News Disaster Link. If you think you are safe on Planet Earth, then a quick look at this site could soon change your mind.

Finally, we have a feature on the contributions of women to the geosciences and the ASEG in particular. It is my belief that we should be exploring ways to put more emphasis in our society on promoting the professional development of women and recognising their achievements. So we have some thoughts on this issue too.

ASEG-PESA Sydney 2004

The planning for the ASEG-PESA International Conference in August 2004 is going ahead well. All participants/authors should be working hard on their presentations and abstracts, so that we can have a first class event worthy of the importance of resource exploration in today's world. It is fitting that the conference will be organized jointly by PESA and the ASEG, because the boundaries between our professional societies are becoming increasingly blurred in our increasingly multi-disciplinary world.

Sponsorship for the meeting is also going well, with WesternGeco agreeing to be a Platinum Sponsor and Veritas and Oil Search on board as Gold Sponsors.

Make sure that Sydney 2004 is locked into your calendars for next year.
Website: www.ausimm.com/pacrim2004

New Corporate Sponsor

Sponsorship is important to the ASEG because of our links to many facets of the resource and exploration industries. It is therefore very pleasing to welcome a new sponsor for 2004: Outer-Rim Exploration Services.

Outer-Rim Exploration Services was established in 1993 to offer professional and reliable EM contracting services to the exploration and mining industry. Utilising the Crone PEM system, Outer-Rim has grown to be one of the top surface and downhole EM operators in Australia.

Recently, through a licence agreement with the CSIRO, Outer-Rim can now offer surveys using the LANDTEM (SQUID) system. Preliminary case studies have shown this system is capable of detecting conductors beneath conductive overburden in WA, previously not seen by conventional coil systems.

We trust that the relationship will be mutually beneficial.

Seasons Greetings

This is the last issue of *Preview* for 2003, and I would like to take this opportunity to thank our contributors, readers, advertisers, sponsors and publisher for their support during the year. I hope you all have a relaxing Christmas and that the New Year brings prosperity and exciting challenges for us all—even if it is to be an election year.

David Denham

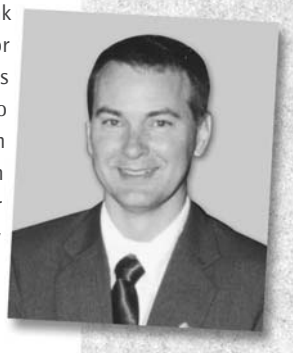
Both Kevin Dodds and I participated in the SEG's Annual Conference and Council Meeting in Dallas. The mood was in my opinion very upbeat with almost 7000 delegates, 1000 booths, and some 650 technical papers! An excellent overview of all the papers with their expanded abstracts can be found at http://meeting.seg.org/techprog/techprog.shtml.

The opportunity was used to promote our upcoming Sydney conference with a poster display in the SEG booth dedicated to upcoming conferences and also by handing-out many conference announcement cards. At the Asia/Pacific luncheon some background was given to 60 people interested in the region, on the ASEG itself, our cooperation with SEGJ and KSEG, the launch of the micro-tremor book, and again on the Sydney conference. The promotional video for the Sydney conference was particularly well received. Kevin Dodds also discussed activities in our region during the meeting of the Global Affairs Committee. We used the opportunity to have a meeting with SEGJ on possible joint publications at this conference as well. The SEGJ made it clear that they are very keen to have an annual joint issue of Exploration Geophysics. We will trial one such issue early next year (Vol 35, No 1) and see how well it is received.

Kirsty Beckett (President of the WA Branch) attended the Science Meets Parliament (SMP) day in Canberra as the ASEG representative. Her group debated for over two hours with WA Senator David Johnson on the following subjects:

- Kyoto Protocols
- Alternatives to Kyoto
- Future developments of carbon sequestration in soil
- Difficulty of capital raising for new technology business ventures
- Potential grants and incentives to encourage new technology ventures
- State of the environment in Western Australia
- Impediments to farmers in implementing new land management practices
- Poor coordination of salinity management and natural land management issues in WA
- Lack of formal advice centre for land management in WA
- The need for Federal guidance in land management decision making, crossing political boarders
- Lack of support structures for young scientists in contract positions
- Generation gap in geosciences, the causes and impact this situation presents
- Australia's 'Brain-Drain' and why young scientists are leaving Australia
- Land right issues in Australia and the impact on mining and exploration

Senator Johnston is a big supporter of the SMP day. With few scientists able to make the trip over from WA, Senator Johnston assured Kirsty that many of the Western Australian Members of Parliament were eager to speak with WA scientists. Possibly, this is valid for representatives from other states as well, so there is perhaps a case for a larger group of geophysicists to attend the SMP day next time. Kirsty identified an opportunity to have more facilitated discussions in future SMP days, such that scientists with similar interests but diverse backgrounds could more easily identify each other and engage in outcome driven discussion of a topical issue. This would allow everyone to benefit from the rather unique assembly of multiple scientific disciplines.



Klaas Koster

Klaas Koster

Aims and Scope

Preview is published by the Australian Society of Exploration Geophysicists. It contains news of topical advances in geophysical techniques, news and comments on the exploration industry, easy-to-read reviews and case histories of interest to our members, opinions of members, book reviews, and matters of general interest.

Contents

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Contributions

All contributions should be submitted to the Editor via email at denham@atrax.net.au. We reserve the right to edit all submissions; letters must contain your name and a contact address. Editorial style for technical articles should follow the guidelines outlined in *Exploration Geophysics* and on ASEG's website www.aseg.org.au. We encourage the use of colour in *Preview* but authors will be asked in most cases to pay a page charge of $440 per page (including GST for Australian authors) for the printing of colour figures. Reprints will not be provided but authors can obtain, on request, a digital file of their article, and are invited to discuss with the publisher, RESolutions Resource and Energy Services Pty Ltd, purchase of multiple hard-copy reprints if required.

The text of all articles should be transmitted as a Word document. Tables, figures and illustrations should be transmitted as separate files, not embedded in the Word document. *Raster images should be supplied as high-resolution (300 dpi) tiff files wherever possible. Vector plots can be supplied using software packages such as Corel Draw or Illustrator.* Illustrations produced in any other software packages should be printed to postscript files. Authors are encouraged to contact the publisher, RESolutions, for information to assist in meeting these requirements.

References

References should follow the author (date) system as used by the SEG (see their website for full details). When reference is made in the text to a work by three or more authors, the first name followed by et al. should be used on all occasions. References should be listed in alphabetical order at the end of the paper in the standard form:

Blackburn, G. J., 1981, Seismic static corrections in irregular or steeply dipping water-bottom environments: *Expl. Geophys.*, **12**, 93–100.

Abbreviations and units

SI units are preferred. Statistics and measurements should always be given in figures e.g. 10 mm, except where the number begins a sentence. When the number does not refer to a unit of measurement, it is spelt out, except where the number is greater than nine. Confusing mathematical notation, and particularly subscripts and superscripts, should be avoided; negative exponents or the use of a solidus (i.e. a sloping line separating bracketed numerator and denominator) are acceptable as long as they are used consistently. The words 'Figure' and 'Table' should be capitalised (first letter) and spelt in full, when referred to in the text.

Deadlines

Preview is published bi-monthly, February, April, June, August, October and December. The deadline for submission of all material to the Editor is usually the 15th of the month prior to the issue date.

Advertisers

Please contact the publisher, RESolutions Resource and Energy Services Pty Ltd, (see details elsewhere in this issue) for advertising rates and information. The ASEG reserves the right to reject advertising, which is not in keeping with its publication standards.

Advertising copy deadline is the 22nd of the month prior to issue date. Therefore, the advertising copy deadline for the February 2004 issue will be 15 January 2004. A summary of the deadlines for future issues is shown below:

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108 Feb 2004	15 Jan 2004	22 Jan 2004
109 Apr 2004	15 Mar 2004	22 Mar 2004
110 June 2004	15 May 2004	22 May 2004
111 Aug 2004*	***3 July 2004***	***19 July 2004***

**Conference Issue, abstracts and biographies to be submitted by 28 May 2004*

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[1] *Members of the standing and ad hoc committees are listed on the ASEG website*

2004

February 8–13
Geological Society of Australia
17th Australian Geological Convention, Hobart, Tasmania
Theme: Dynamic Earth: Past, Present and Future
Website: www.17thagc.gsa.org.au

February 22–26
EEGS Annual Meeting and Exhibition (SAGEEP)
Theme: Geophysics and Global Change—Turning challenges into opportunities
Venue: Colorado Springs, USA
Website: www.sageep.info

8–14 March
The Mining Executive Development Program (MEDP)
WA School of Mines, Curtin University of Technology
Venue: Joondalup Resort (Country Club Boulevard, Connolly, WA GPO Box U1987)
Email: mineral_economics@curtin.edu.au

March 28–31
APPEA Conference & Exhibition
Venue: National Convention Centre, Canberra
Contact: jhood@appea.com.au
Website: www.appea.com.au/Events/AppeaEvents.asp

March 31–April 4
International Conference and Exposition (SEG Beijing/SPG/SEG) - postponed from 2003
Venue: Beijing, China
Website: www.spgol.org

May 17–21
Joint Meeting: AGU and the Canadian Geophysical Union (CGU)
Sponsors: AGU, CGU
Venue: Montreal, Canada
Website: www.agu.org/meetings

June 7–11
66th EAGE Conference and Exhibition
Venue: Paris, France
Website: www.eage.nl

August 15–19
ASEG, in collaboration with PESA
17th International Conference and Exhibition,
Theme: Integrated Exploration in a Changing World
Venue: Sydney Convention Centre, Sydney NSW
Website: www.aseg-pesa2004.org.au

September 19–22
Pacrim 2004
Theme: Hi Tech and World Competitive - Mineral Success Stories Around the Pacific Rim
Adelaide, SA
Website: www.ausimm.com

September 27–October 1
SEG 2004
Theme: Predictive Mineral Discovery Under Cover
Sponsor: Society of Economic Geologists, Society of Geology Applied to Mineral Deposits and Geoconferences (WA) Inc.
Venue: Perth, WA
Website: www.cgm.uwa.edu.au/geoconferences/seg2004/index.asp

October 10–15
SEG International Exposition & 74th Annual Meeting
Venue: Denver, Colorado, U.S.
Website: www.seg.org

December 13–17
2004 AGU Fall Meeting
Venue: San Francisco, California, U.S.A.
Website: www.agu.org/meetings

2005

10–13 April 2005
2005 APPEA Conference & Exhibition
Perth (at the new Convention Centre facility)
Contact: Julie Hood at: jhood@appea.com.au

Earth Sciences only win 4.5% of total grants in ARC's 2004 program

The ARC grants for 2004 were announced in October this year. The total commitment by the Australian Government for the 965 new research projects starting in 2004 will be $248 million over three years of which $103.2 million will be spent in 2004. This is a drop in the number of new projects from 1252 for 2003 but the average funding per project has increased (as you would expect) from $82k in 2003 to $91k in 2004 for the Discovery Program and from $179k in 2003 to $219k in 2004 in the Linkage Program. The percentage of grants in the Earth Sciences has dropped from 6% of the total grants in 2003 to 4.5 % in 2004.

The full list of new and current projects is available on the Australian Research Council's Website: http://www.arc.gov.au/arc_home/default.htm. Of the successful 661 new Discovery Project Grants only 31 are in the Earth Sciences. Those with a geophysical focus are listed below:

Thick-skin continental deformation and the rheology of faulted continental lithosphere
Researchers: L N Moresi and A Lenardic
Funding: 2004, $90 000; 2005, $90 000; 2006, $80 000
Administering Institution: Monash University
Project Summary: We plan to study the way in which major, long-lived faults influence the large-scale deformation of continental lithosphere in response to plate and mantle derived stresses. We will develop realistic computer models of networks of faults embedded in the crust to examine the way large faults (e.g. the San Andreas fault in California) interact with the deep crust and shallow mantle and the way they interact with each other. No one previous model has been able to incorporate all the important dynamics. The work will be used by structural geologists, planetary scientists and be a valuable tool in mineral exploration.

Accurately locating the depth and distribution of saline waters with improved shallow conductivity sounding using broadcast radio transmissions
Researchers: J C Macnae and J E Reid
Funding: 2004, $75 000; 2005, $75 000
Administering Institution: RMIT University
Project Summary: Conductivity meters such as the EM31 are in routine use for mapping shallow salinity, but provide no depth information. This research will provide methodology using broadcast radio transmissions to additionally provide the depth information needed to interpret shallow layering and inhomogeneity. Instruments will initially be tested on the ground, but are ultimately intended to be applied from the air, where existing systems have no resolution in the top 5 m. The method will provide crucial root-zone data for precision agriculture in salt-affected areas, and address accurate salt mapping issues in the major efforts to combat Australia's salinity problems.

Growth and Decay of ice sheets during glacial cycles: the example of Europe
Researchers: K Lambeck
Funding: 2004, $100 000; 2005; $100 000, 2006: $90 000
Administering Institution: The Australian National University
Project Summary: The proposal is to develop a comprehensive model for the growth and decay of the ice sheets of Europe during the last glacial cycle, using a combination of diverse field evidence with geophysical modelling. The outcomes provide boundary conditions for climate models (times of inception and decay, ice limits, ice thickness) including processes driving climate as well as constraints on the Earth's mantle viscosity. Thus the project contributes to the quantitative characterisation of both climate change and planetary structure. In an Australian context, these outcomes form important elements in the development of predictive models for sea-level change.

Multi-arrival wavefront tracking for improved seismic imaging of the Earth's interior
Researchers: N Rawlinson and M Sambridge
Funding: 2004, $85 000; 2005, $85 000; 2006, $85 000
Administering Institution: The Australian National University
Project Summary: The complex nature of many seismic wavetrains can usually be attributed to the multi-pathing of elastic wave energy between source and receiver. Typical analysis, e.g., seismic tomography, uses few of these arrivals. This project is designed to improve the exploitation of the information on seismograms by

tracking the various arrivals in complex media to provide better constraints on Earth structure. To achieve this goal, new methods for constructing multi-arrival wavefronts will be developed and applied to a range of seismic data from Tasmania to produce high resolution images of the crust and upper mantle.

The Role of Hydrous Fluids in Fault Processes: An Experimental Study
Researchers: E Tenthorey
Funding: 2004, $70 000; 2005, $70 000; 2006, $66 000
Administering Institution: The Australian National University
Project Summary: The proposed project seeks to understand how hydrothermal reactions in fault zones affect various physical properties such as fault strength and permeability. The project will be conducted by performing high pressure experiments which simulate natural conditions. I will also develop new analytical techniques to characterize the microstructural evolution of faults, with a focus on understanding how any changes alter the hydrologic behaviour of the fault. This study will shed much needed information related to the mechanisms of earthquake nucleation, and to the formation mechanism of fault-hosted gold deposits.

In the Linkage – Infrastructure Equipment and Facilities category 65 grants totaling $25.8 million there were only two (and one of these was focused more one atmospheric science) successful Earth Science bids these are listed below:

Luminescence stimulation and detection facility for dating of Quaternary geological and archaeological sediments
Researchers: R G Roberts, C V Murray-Wallace, A R Chivas, P J Hearty and J F Nott
Funding: 2004, $109 595
Administering Institution: University of Wollongong
Partner organisation: James Cook University
Project Summary: Reliable ages are required in the Earth and Archaeological sciences. Luminescence dating is a flexible geochronological technique for diverse deposits. It exploits the radiation-induced thermally (TL) and optically stimulated luminescence (OSL) emissions from minerals exposed to sunlight before burial. Recent technical developments have made feasible OSL dating of small samples (e.g., individual sand grains) and sediments deposited during the past 0.5-1 million years. We request funds for a Risø TL/OSL system with single-grain attachment to resolve the timing of sea-level, climate and landscape changes, and the chronology of human evolution and dispersal, in Australia and Southeast Asia.

Completion of the Tasman International Geospace Environment Radar (TIGER)
Researchers: P L Dyson, F W Menk, J A Bennett, P J Wilkinson, B D Ward and M Pinnock
Funding: 2004, $583 605
Administering Institution: La Trobe University
Partner organisations: The University of Newcastle, Monash University, Defence Science and Technology Organisation, IPS Radio and Space Services, and the British Antarctic Survey
Project Summary: TIGER is part of an international high frequency radar consortium (SuperDARN) studying the coupling of space weather processes to the ionosphere. This is critical for radio, navigation and surveillance networks. TIGER provides important new information because it extends the global radar coverage significantly equatorward, and it can be combined with other radars in Antarctica and Alaska. However, only one of the two TIGER radars necessary to carry out these studies has been built. This proposal is for completion of the second radar, to be located in New Zealand. The US Air Force has already granted A$443k toward this project.

Learned Academies successful in ARC grants

The Learned Academies all did well in winning ARC Special Projects Linkage Grants.

These have a maximum funding duration of 3 years but an application must be submitted each year for ongoing projects. Five applications were received and all five will receive funding, as shown in Table 1.

This funding offers real opportunities for the Academies to make significant impacts on major issues.

Government invests $92 million for START grants

Not to be outdone by the ARC investment, Minister for Industry, Tourism and Resources, Ian Mafarlane announced in November that a total of $91,867,962 had been approved for grants and loans agreement during the period from January–October 2003.

R&D Start is a competitive, merit based grants and loans program that supports businesses to undertake research and development and its commercialisation. This program forms part of the $3 billion Innovation Statement, Backing Australia's Ability, that underscores the Government's commitment to innovation. Unfortunately, a quick look through the list did not reveal any focused on exploration or the geosciences. Some one may be missing out on useful grants to develop research outputs.

Evaluation of the Cooperative Research Centres Program completed, and.....

As part of the government's analysis on how it should advance beyond the Backing Australia's Ability investment into R&D in Australia, a number of reviews have been commissioned (see October *Preview*, p 2). The reports from these studies are now being released. The first report to be

Academy	Project Title	Total Project Allocation
National Academies Forum	Sustainability: identifying the range of options for Australia	$97 000
Academy of the Social Sciences Australia	What is to be done with management ethics? Addressing national needs and priorities	$95 000
Australian Academy of Technological Sciences and Engineering	The impact of climate change on Australia's physical infrastructure	$85 000
Australian Academy of the Humanities	Electronically enabled collaboration in humanities research	$75 000
Australian Academy of science	Maximising the benefits from international scientific linkages	$100 000
Total Recommended		**$452 000**

Table 1.

released was written by Howard Partners Pty Ltd under contract to DEST. It contains 30 recommendations embedded in a 228 page report. I will not proceed to go through all the recommendations but the two main ones are that:

1. The CRC Program should continue, but with design modifications to reflect changes in the environment for public-private sector research collaboration and the creation of new business models for the commercialisation of publicly funded research, as identified and canvassed in this Report; and
2. The CRC Program be promoted on the basis of an overarching purpose 'to create and sustain active public-private research partnerships oriented towards the adoption and utilisation of research in a national, industry and business context'.

In other words the industry/private sector focus will be strengthened, probably at the expense of the public good national benefit CRCs.

.....the National Research Infrastructure Taskforce reports to government

The task force, which was set up earlier this year (see October 2003 *Preview*, p2) has made many recommendations but perhaps the most important are:

1. Infrastructure strategies should be aligned with research strategies, to ensure that the research infrastructure investments support the strategic direction of research at national, regional, institutional and discipline levels.
2. A National Research Infrastructure Council (NRIC) be established to develop, implement, review and monitor the National Research Infrastructure Strategy.
3. The Commonwealth should actively engage the States and Territories to collaborate in the National Research Infrastructure Strategy.
4. The National Research Infrastructure Strategy should set out models for access regimes that ensure that the research community as a whole can gain benefit of the investment (within constraints of access regimes e.g. peer review).
5. All research infrastructure investments with a funding component in excess of $5 M should be pursued within one of the governance/management models set out in the National Research Infrastructure Strategy.
6. Investment in research infrastructure should be made only where the business case for investment identifies the sources of funds and revenues which will ensure that the research infrastructure can support the research it underpins in an ongoing, relevant and viable way.
7. Australian Government programs for research infrastructure be established as ongoing programs, to the extent possible under Australian Government Budget arrangements, rather than as intermittent activities.
8. Government investment in research infrastructure should buy access across the whole of the research platform.
9. An online database of research infrastructure be established to promote access to infrastructure across the whole of the research platform, to inform investment decisions, and to provide transparent and accessible information on access and charging regimes.

The recommendations are very important for the geosciences, because we use several large infrastructure facilities such as the Australian National Seismic Imaging facility, the SHRIMP spectrometers and the rock property laboratories. So it will be interesting to see how the government responds to the report.

The full text of both reports can be found on the DEST website at: http://www.dest.gov.au.

Eristicus
November 2003

John Glover, The University of Western Australia

Hugh Doyle 1927–2003

Many Earth scientists will have learnt with sadness of the death at 76 of Hugh Aynsley Doyle in Sydney, on 29th August, 2003. Hugh was born in Sydney, the son of Richard and Alma Sadie Doyle on April 21, 1927. He graduated from the University of Sydney with a BSc in 1947, and subsequently undertook pioneering geophysical work in many parts of the Australian continent, its offshore possessions, and New Guinea. He married Brenda Clark, an American. Some of the observations given below come from an unpublished manuscript entitled *Fifty Years in Geophysics*, written by Hugh himself.

Hugh was employed as geophysicist with the Bureau of Mineral Resources from 1948–1956. In 1951, he began a year at Heard Island as the first geophysicist to winter there. In 1952, by contrast, he took part in a search of the Port Moresby area for the site of a proposed seismic magnetic and ionospheric observatory. Six years later, he was to return to New Guinea to record US nuclear explosions in the Pacific. In 1953 he was assigned to record the first nuclear explosion at the Emu Site near Maralinga in South Australia. The seismic party recorded a reflection from the Moho, for the first time in Australia. The following year he was transferred to the Watheroo Magnetic Observatory in Western Australia, which, although professionally rewarding, seems to have represented a low spot on his social calendar. In 1956 he made seismic records of atomic explosions in Australia, producing the first accurate measurements of Australia's crustal thickness along the Trans-Australia railway line, where it averages 37 km. The results appeared in *Nature*.

Hugh became a research fellow in geophysics at ANU from 1956–69, and in 1965 began a stay of almost two years at the South West Centre for Advanced studies in Dallas Texas, examining delays in S-wave travel-times in tectonic regions. In 1966 he studied the Meckering earthquake with Ian Everingham and Peter Gregson, producing a joint report in *Nature*.

Hugh was Senior Lecturer at the University of Western Australia from 1970–89, and was the first lecturer in geophysics in Western Australia. He kept his student lecture material meticulously up to date, and was noted for his rigorous marking of student assignments. Hugh was conservative in many of his views, and not surprisingly in a university environment, was rarely short of participants for lively debate. At the conclusion of his teaching career, he generously donated capital for the establishment of the Hugh Doyle Prize in Geophysics, to be awarded annually at The University of Western Australia. He was appointed Honorary Senior Research Fellow at UWA.

Hugh was a member of the ASEG from 1973 until his death this year.

After the publication of his book *Seismology*, Hugh retired to Sydney. He leaves his daughter Anna Clark Doyle, who is a Chinese language specialist.

Call for nominations: ASEG Honours and Awards

During the 17th ASEG Conference to be held in Sydney in August 2004, several categories of Honours and Awards will be presented to members who merit recognition for distinguished service to the Society and to Exploration Geophysics. ASEG Members are invited to submit nominations for the following awards:

1. ASEG Gold Medal

'*For exceptional and highly significant distinguished contributions to the science and practice of geophysics by a member, resulting in wide recognition within the geoscientific community.*' The nominee must be a member of the ASEG.

2. Honorary Membership

'For distinguished contributions by a member to the profession of exploration geophysics and to the ASEG over many years.' Requires at least 20 years as a member of the ASEG, except where the nominee is a recipient of the ASEG Gold medal.

3. Grahame Sands Award

'*For innovation in applied geophysics through a significant practical development of benefit to Australian exploration geophysics in the field of instrumentation, data acquisition, interpretation or theory.*' The nominee does not need to be a member of the ASEG.

4. Lindsay Ingall Memorial Award

'*For the promotion of geophysics to the wider community.*' This award is intended for an Australian resident or former resident for the promotion of geophysics, (including but not necessarily limited to applications, technologies or education), within the non-geophysical community, including geologists, geochemists, engineers, managers, politicians, the media or the general public. The nominee does not need to be a geophysicist or a member of the ASEG.

5. ASEG Service Medal

'*For outstanding and distinguished service by a member in making major contributions to the shaping and the sustaining of the Society and the conduct of its affairs*

over many years' The nominee will have been a member of the ASEG for a significant and sustained period of time and will have at some stage been one of the following:

- Federal President, Treasurer or Secretary,
- State President, Conference Chairman or Standing Committee Chairman
- Editor of Exploration Geophysics or Preview

6. ASEG Service Certificates

'For distinguished service by a member to the ASEG, through involvement in and contribution to State Branch committees, Federal Committees, Publications, and Conferences.'

Nomination Procedure

For the first four award categories any member of the society may nominate applicants. These nominations are to be supported by a seconder, and in the case of the Lindsay Ingall Memorial Award by at least four geoscientists who are members of an Australian geoscience body (eg GSA, AusIMM, AIG, IAH, ASEG or similar). Nominations for the ASEG Service Medal and the ASEG Service Certificates are to be proposed by the State and Federal Executives.

Nominations including digital copies of all relevant supporting documentation are to be sent to:

Chairman, ASEG Honours and Awards Committee,
8 Kearns Crescent
Ardross WA 6153
Email: bill@sgc.com.au
Tel: 08 93162814
Fax: 08 93161624

Applications will close on June 15th 2004

New Members

ASEG welcomes the following new members to the Society. Membership was approved by the Federal Executive at its meetings on September 24th and November 5th 2003.

Name	Organisation	State
Patrick Andre	CGG Australia Services	WA
Said Amiri Besheli	Curtin University of Technology	WA
Cameron Inglis Blyth	Raptor Technical Services	WA
David Charles Fursman	WesternGeco	WA
Keith Hickey	Chevron Texaco	WA
Thong Ha Huynh	Gravity Capital Ltd	Vic
Dominic Koosimile	DeBeers Prospecting (Pty) Ltd	Botswana
Anne Elizabeth Morrell	University of Auckland	NZ
George Randall Nickson	Macal Geoscience	WA

News from FASTS

Science meets Parliament 2003 (SmP 2003)

The fifth annual science meets Parliament day was held on October 15th 2003.

With only five out of 226 Federal Parliamentarians having a background in science, it is important to build better links between science and Parliamentarians. However, most MPs are really interested in talking science. They want to know what science and technology can deliver, and more about the possibilities for new industries and solutions for environmental problems.

From a full list of 17 topics nominated in the National Research Priorities, the MPs selected the following three issues as of the greatest significant to them:

Water: a critical resource,
Land degradation: overcoming soil loss, acidity and salinity, and *Frontier technologies*: new industries of the future.

This SmP meeting was the biggest yet. Registration numbers were noticeably higher than last year, with 25 more Parliamentarians and 40 more scientists participating than in 2002. 152 Parliamentarians accepted an invitation to talk about science and there were over 200 scientists registered to talk to them.

The three key issues for FASTS were:

1. Australia needs to redouble its efforts in the public investment in research (building on Backing Australia's Ability),
2. We should encourage private sector R&D activity, with rewards for long-term investment, and
3. We need a larger public investment into the higher education system.

A dinner at Old Parliament House provided a further opportunity for scientists and Parliamentarians to mingle and exchange views. The dinner was addressed by John Wolpert, team leader of the *IBM Extreme Blue Innovation Lab* in Austin, and by Graham McDonald from pharmaceutical company Merck, Sharp and Dohme, the U.K. subsidiary of Merck and Co. Inc.

A fitting end to a great event.

New President of FASTS

Following the Annual General Meeting of FASTS, held on Thursday October 16th, Professor Snow Barlow began a two-year term as President, succeeding Professor Chris Fell. Snow is a plant scientist at the University of Melbourne, where he heads the School of Agriculture and Food Systems.

David Denham's four-year term as Vice-President has now ended, and he has been replaced by Judy Mousley of the Faculty of Education at Deakin University.

The other office bearers on the Executive Committee for the next 12 months are:
Vice President: Rob Norris, Dean of Science at Monash University,
Secretary: John O'Connor of the University of Newcastle,
Treasurer: John Rice of Flinders University
Policy Committee Chairman: Ken Baldwin, ANU.

Executive Director leaves

Toss Gascoigne has announced his departure from FASTS, after more than nine years at the helm of Australia's premier scientific body. Toss has been instrumental in establishing FASTS as the Peak Council representing working scientists and technologists in Australia. He is to take up a position as inaugural director of CHASS, the Council for the Humanities, Arts and Social Sciences in 2004. The position of Executive Director has been advertised, and it is hoped to fill it early in 2004.

More information on the above can be obtained from the FASTS' website: www.fasts.org.

Australian Capital Territory – by David Robinson and Ben Bell

The ACT Branch of the ASEG endeavours to offer its members diversity with respect to the topics presented at its technical meetings.

On June 25th Paul Tregoning from the Research School of Earth Sciences, ANU presented a talk entitled *PNG Tectonics, Aftershock Relocations and GPS Estimates of Co- and Post-Seismic Deformation*. Paul talked about three major earthquakes that occurred in the New Ireland and New Britain region of eastern Papua New Guinea in November 2000. The first event (M_w=8.0) ruptured a strike-slip boundary, and caused surface displacements of up to 5 m. The two subsequent events (M_w=7.8) were thrust events on the New Britain Trench. The surface deformation was recorded by a geodetic monitoring network installed in 1998. GPS measurements of the monitoring sites subsequent to the earthquakes have led to estimates of co- and post-seismic movement of the Earth. Paul described how aftershocks were used to constrain the location of the two fault planes and discussed the fault parameters and slip distribution modelled by a non-linear inversion.

On August 13th Spiro Spiliopoulos from Geoscience Australia gave a talk entitled *Observations and Preliminary Characterisation of Signals from the Cape Leeuwin Hydroacoustic Station, WA*. Spiro discussed Australia's commitment to the Comprehensive Nuclear-Test-Ban Treaty and he described the Cape Leeuwin hydroacoustic station, which is located approximately 100 km to the southwest of Cape Leeuwin, WA. This station forms a component of the International Monitoring System for nuclear explosions. Twelve months of recording has revealed that the station is capable of recording a wide variety of signals ranging from whales through to earthquakes. As well as playing some whale songs, Spiro described how the different signals could be classified.

Des FitzGerald (Intrepid Geophysics) revealed how Extended Euler Deconvolution has the ability to calculate depths and classify major fault contacts from both gravity and magnetic anomalies; technical meetings are designed to reinforce the breadth of opportunities for the application of geophysics. His presentation was given at Geoscience Australia on October 22nd.

As meetings are always closed with the consumption of locally produced wines and an assortment of nibbles, technical meetings also provide those of us living in Canberra with an invaluable forum for networking and catching up from friends. Naturally, visitors are most welcome.

The ACT Branch was also fortunate to attract Tim Pippett to Canberra on September 24th where, over a lunch, Tim presented a number of case studies illustrating the potential of geophysics to locate environmental contamination such as landfills, chemical pollution or ordnance in the sub surface.

South Australia – by Graham Heinson

Our July meeting attracted 53 people, including 28 students, to hear Phil Harman give a talk entitled *Falcon – what's the attraction?* His presentation, on an exciting development in Australian geophysics, was much appreciated by members, and we thank Gravity Capital Ltd. for their generous sponsorship of the evening. In mid-August, Martin Landro - University of Trondheim, Norway and Esso Distinguished Lecturer for 2003, presented a provocative talk as a co-hosted a meeting with PESA. Professor Landro's talk on *Not fully explored geophysical methods (4C methods, gravimetric methods, electromagnetic methods etc.)* provided something for everyone, and provoked a wide-range of questions. We thank PESA for their organisation and ESSO for sponsorship. Finally, in late August, Tracy J. Stark, President of STARK Research talked on *A new twist on 3D interpretation—Building and using a Relative Geologic Time Volume* to an appreciative audience. Rock Solid Images kindly provided sponsorship for the evening.

In mid-August, the ASEG SA Branch committee had the challenge of selecting the best red and white wines for the 2003 ASEG wine offer, advertised in this edition of

Preview, and on the web site. Stephen Tomlin from Santos put in a tremendous effort in the organisation of this event. Eighteen white and 28 red wines were sampled with dinner at Jarmer's restaurant on Kensington Road, Adelaide, and two fine wines emerged from the pack. Put in your order today!

In October, we hosted two meetings. On October 1st, John Hart from Minotaur Resources gave an excellent talk on the *Geophysics of the Prominent Hill Iron Oxide Copper-Gold Deposit*. The talk, on an exciting development in Australian exploration was much appreciated by members, and we thanks Minotaur for their generous sponsorship. In mid-October, our Industry Night attracted 50 people, indicating renewed optimism in exploration. The four speakers were Tony Wright from Cooper Energy, Colin Skidmore from Southern Cross Resources, Volker Hirsinger from Petrosys and Steve Busuttil on new developments with MIMDAS. Thanks to all our speakers, and their companies for their sponsorship.

The ASEG Melbourne Cup, proudly sponsored by Beach Petroleum, was a highlight of the geoscience year in South Australia. As ever, Rod Lovibond and Suzanne Roberts organised a very enjoyable afternoon for almost 80 people. Lunch in the afternoon sunshine of the Duke of York Hotel beer garden encouraged table syndicates to bet high for the race!

By the time this Preview is delivered, the ASEG Wine Offer will have closed. So far, orders have been streaming in and we hope that those of you who bought a case or two will enjoy a glass of red or white as summer draws near.

Our final meeting of the year will be another popular Student Night at the end of November, and the annual Christmas Party early December. Look out for details by e-mail and on the web site www.aseg.org.au/sa

New South Wales – by Carina Simmat

Student involvement in the NSW Branch reached a peak last month with the very successful Student night. Students from Macquarie, Sydney and New South Wales Universities showed outstanding professionalism in presenting a summary of their 2003 Honours research. Questions from the audience were answered well but unfortunately there were all too few members present to appreciate the experience.

Lachlan Gibbins from Macquarie University presented *A Geophysical investigation of two upland swamps on the Woronora Plateau*. The main aim of Lachlan's thesis was to describe the role of bedrock conditions in the preservation of upland swamps using geophysical techniques. Lachlan defended his use of the Schlumberger Array extremely well during questioning.

Kathleen McMahon also from Macquarie University gave us a very entertaining talk on *Seismic Reflection studies of the Amery Ice Shelf*. Kathleen spent three months in the icy winds of Antarctica to acquire some interesting data for her Honours project.

Nick Dando from Sydney University has designed a *3D Borehole imaging using photogrammetric methods*. Nick's presentation demonstrated that by accurately imaging dry borehole breakout patterns in stereo one can determine the direction of major stresses.

David Lacey from Sydney University presented his *3D Analysis of the Gallipoli Peninsula; 1915–2003*. David's project involved combining modern (day) satellite data and 1915 Aerial Photography overlain on a digitised 1919 contour map series of the area. David showed us very impressive flythrough movies of the Gallipoli Peninsula.

Andrew Spyrou from the University of New South Wales, presented *Three dimensional three component shallow seismic refraction surveys in the Spicers Creek Catchment, Central Eastern New South Wales*. Dryland salinity occurs extensively throughout the Spicers Creek Catchment with groundwater being discharged from the surface at several locations. Andrew presented his work on determining the location of major shear zones that seem to correlate with this groundwater discharge.

As the committee could not pick a clear best presentation, all five students were given a prize of equal value. Thank you to all of the students who presented.

Western Australia – by Anita Heath

The branch held a very enjoyable golf day in conjunction with PESA. Many thanks to Margarita Norvill for doing such a good job with the organisation. Congratulations to the winners, details below. Charities are yet to be decided.

Here are the details of the winning team for the PESA/ASEG Golf Day. Charities are yet to be decided.

Corporate Challenge Winning Team	General Winning Team
Clowns Pocket	Team 10
Laurie Brown	Bob Beattie
Aimie Hampson	Dave Brown
Mike Purves	Kim McInerney
Mark Sofield	Brent Steedman

Meetings are held at 5.30pm on the first Wednesday in the month at the ARRC lecture theatre in Bentley.

The AGM of the WA Branch was successfully executed on December 3rd (followed by a BBQ at Curtin University) to a quorum of over 30 members. Elected to the WA Branch

Executive Committee for 2004 were:
Don Sherlock - President
Kirsty Beckett - Secretary
Levin Lee - Treasurer

In his first address as President of the WA Branch, Don emphasised the need to strengthen our ties with other geoscience societies. As President of the WA Branch, Don will be actively seeking more opportunities for joint activities between the geoscience societies in 2004.

Thank you to the efforts of the committee this year - Tim Cox, Kevin Dodds, Peter Elliott, Howard Golden, Guy Holmes, David Howard, Graham Jenke, Anton Kepic, Liz Clydsdale, John McDonald, Steve Mudge, Greg Street and John Watts.

With special commendations to committee members - Kim Cook (outgoing treasurer), Megan Evans (outgoing secretary), Brian Evans, Anita Heath, Tom Kearney, Levin Lee, Margarita Norvill and Don Sherlock.

Kim Cook presenting the Treasurer's report with baby Brodie in arms

Nature's Hazards

By Margarita Norvill

Email: margarita@geophy.curtin.edu.au

A natural hazard becomes a natural disaster when a geophysical process or event interacts detrimentally with human society. Natural hazards can be of three main types: geological, meteorological and space hazards.

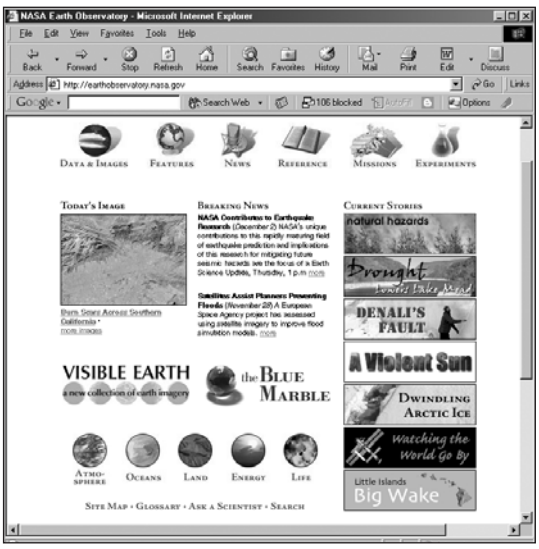
In 2000, one in 30 people worldwide were affected by natural hazards, up to 15 million lives were lost due to natural hazards in the last millennium. The 20th century death toll is estimated to be about 3.5 million. On average there was 128 000 deaths per year since 1971 and 136 million people affected. For natural disasters between 1971 and 1995 97% of the deaths and 99% of affected people were from developing counties. Between 1991 and 1995 damage worldwide due to natural hazards was ~US$439 billion (http://www.benfieldhrc.org/).

The Benfield Hazard Research Centre (BHRC)
http://www.benfieldhrc.org/ ★★★½

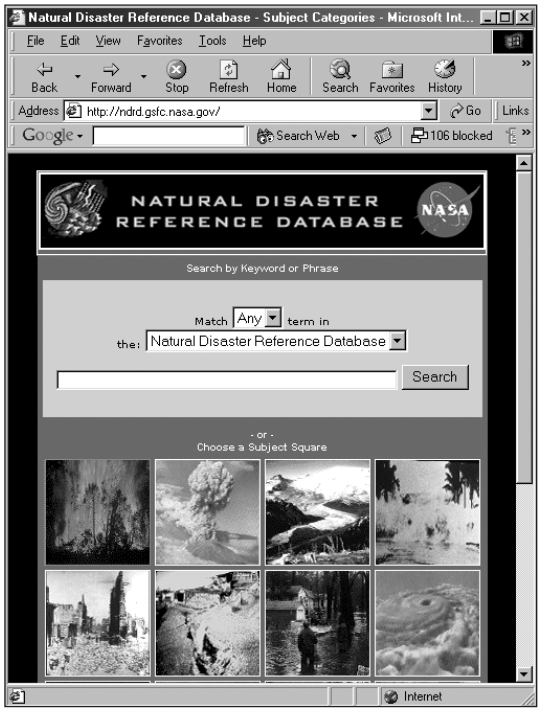
With over 40 researchers and practitioners, the Benfield Hazard Research Centre is Europe's leading multidisciplinary academic hazard research centre. The intellectual products of the BHRC fall into two categories, research into natural hazards and the processes that drive them, and applied studies targeted at reducing the impact of natural hazards on society. The site is full of detailed information on geological and meteorological hazards, with many publications concentrating on impact and prediction of floods volcanic eruptions and windstorms. Seasonal forecasting for Australia's 2003-2004 summer cyclone season will see activity below the 30 year average — primarily as a result of higher than average sea surface temperatures.

Earth Observatory
http://earthobservatory.nasa.gov/ ★★★★★

The purpose of NASA's Earth Observatory is to provide a freely-accessible publication on the internet where the public can obtain new satellite imagery and scientific information about our home planet. The focus is on Earth's climate and environmental change. This is an amazing site it provides great satellite imagery of the earth. Images explore the atmosphere, oceans, land, energy, life and beyond. All elements of the Earth are captured and explained. There are current images of natural hazards, dust and smoke, fires, floods, severe storms, volcanoes and unique imagery such as the largest solar flare observed to date on November 4th this year.



The Natural Disaster Reference Database
http://ndrd.gsfc.nasa.gov/ ★★★½



The Natural Disaster Reference Database is a bibliographic database on research, programs, and results which relate to the use of satellite remote sensing for disaster mitigation. The National Disaster Reference Database was compiled and abstracted from articles published from 1981 though April 2002. This database focuses on the connection of hazards and satellite remote sensing as well as models and process studies through which these can be brought together.

It is a great site for finding references on subjects that you wish to more broadly explore.

Stephen Nelson Department of Earth and Environmental Sciences Tulane University
http://www.tulane.edu/~sanelson/ ★★★½

This is the home page for Associate Professor Stephen A. Nelson. Dr Nelson's research interests include volcanology,

igneous petrology, the Mexican Volcanic Belt, geological hazards and thermodynamics. Lecture notes from some of his courses are available on the web. Specifically his natural disasters course explores planetary setting, earth material systems and cycles, assessing hazards and risk, causes and prediction of earthquakes, volcanoes tsunamis, land slides, floods, extreme weather and meteorites impact. This is a great site for a tutorial in natural hazards.

CBS News Disaster Link ★★★★
http://www.disasterlinks.net/
Mainly an American site, the CBS disaster links page provide links to world wide disasters. Disasters included airplane, avalanche biological and chemical weapons, cyber crime and computer infrastructure, drought, earthquakes, epidemics, floods, heat, hurricanes, icebergs, landslides, lightning, oil spills, relief agencies and organizations, severe weather, space weather, terrorism, tornadoes, tsunamis, typhoons, volcanoes, wind chill, winter storms, El Nino and La Nina. You will find whatever disaster turns you on at this comprehensive site. The links provided are to research institutions, government organisations and news bulletins.

Natural Hazards Centre at the University of Colorado, Boulder
http://www.colorado.edu/hazards/ ★★★½
The Natural Hazards Centre, located at the University of Colorado researches natural hazards and human adjustments to hazards and disasters. The Centre's prime goal is to increase communication among hazard/disaster researchers and those individuals, agencies, and organizations that are actively working to reduce disaster damage and suffering.

The Natural Hazards Observer is the bimonthly periodical of the Natural Hazards Centre. It focuses on news regarding human adaptation and response to all natural hazards and provides a forum for concerned individuals to express opinions and generate new ideas through invited personal articles.

Welcome to Tsunami
http://www.geophys.washington.edu/tsunami/welcome.html ★★★★
The Welcome to Tsunami site has been developed with a broad audience in mind; it contains extensive background information that is intended primarily for the general public, including information about the mechanisms of tsunami generation and propagation, the impact of tsunamis on humankind, and the Tsunami Warning System. The site also contains more detailed information about recent tsunami events that will be of interest to tsunami and interdisciplinary researchers. Check out a great animation of the 1960 Chilean tsunami traveling across the Pacific to Japan, traveling a distance of 17 000 km from the tsunami's source off the coast of Chile.

Asteroid and Comet Impact Hazards
http://impact.arc.nasa.gov/ ★★★★
The Earth orbits the Sun in a cosmic shooting gallery, subject to impacts from comets and asteroids. It is only fairly recently that we have come to appreciate that impacts by asteroids and comets pose a significant hazard to life and property. Although the annual probability of the Earth being struck by a large asteroid or comet is extremely small, the consequences of such a collision are so catastrophic that it is prudent to assess the nature of the threat and prepare to deal with it. Learn about the Torino scale, the 'Richter scale' for categorising the earth impact hazard for asteroids and comets. The Torino scale assesses the seriousness of close encounters by asteroids and comets.

Volcano World – University of North Dakota
http://volcano.und.nodak.edu/vw.html ★★★★½
Volcano world is a comprehensive site that contains information on volcanoes around the world. You can search for volcanoes by world region, country/area, name or description. It shows images of the volcano and provides information on the geology and its activity history. Examples from Australia include the Argyle diamond pipe and the Glass House Mountains. There are instructions on how to build your own volcano, from a play dough model to an explosive volcano model and even an electronic model.

Geoscience Australia Earthquakes and Natural Hazards
http://www.ga.gov.au/urban/ ★★★★½
Information on earthquakes and recent earthquake data, including a monthly report on earthquake and nuclear monitoring, a location to record an earthquake you have felt, and a facility for plotting a seismogram from a seismic observatory in Australia. Risk modelling from statistics of previous events and physical models of earth processes. Risk models include earthquakes, floods, landslides, tropical cyclone winds and storm surge, and coastal erosion.

Star Rating

Content/information available on web pages	2
Navigation friendly	1
Aesthetically Pleasing	1
Currency	1
TOTAL	5

Society, Sound and Growing

Yes! It's that time of year again! I could easily be referring to the festive season, which many of us look towards with mixed feelings of joy and despair (perhaps it is us who feel the joy and our bank accounts that despair). As it happens, however, I am referring not to Christmas, but to membership renewal time. Notices have recently been sent out for the renewal of memberships and the online renewal system is open for business. By the way, our membership as of October 2003, numbered 1403 members, compared with 1312 members, in 2002. It is great to see the society's membership continuing to grow.

Other notices to look out for are in the area of publications. Of particular interest is the volume of Exploration Geophysics (vol 35, no 1), planned for March 2004. This publication represents a joint work between the ASEG, SEGJ (Society of Exploration Geophysicists of Japan) and KSEG (Korean Society of Exploration Geophysicists). A great deal of planning and hard work has gone into this publication and I am sure the results will be good.

Also in publications, the Exploration Geophysics Digital Library (1970 to 2003) is now available to fully paid ASEG members for a pre-release price of $99. Further information and an order form can be found on the ASEG website. The closing date is December 31st, 2003.

On other matters, some changes to ASEG Awards have been recommended by the Honours and Awards Committee and these were ratified by the Federal Executive, at the November meeting. These changes mainly involve the tightening of definitions for the various awards. Also discussed at the November meeting were topics such as arrangements for sharing conference proceeds with the State Branches and the consolidation of society accounting.

Speaking of accounting brings me back to Christmas again! On that note, I would like to wish everyone a happy and safe Christmas and all the best for the New Year.

Lisa Vella
Honorary Federal Secretary

Letters

In Preview 106 (October, 2003), the case study paper, 'Calibration of Honeysuckle Creek Conductivity Depth Images' acknowledged Ross Brodie and Richard Lane for passing on the benefit of their experience in ground-truthing AEM data. Reference should however have also been made in the body of the article to work by Brodie *et al.*, 2003 and Lane *et al.*, 2001 as the source of the method applied. Readers should regard these papers as primary references for the methodology employed.

Furthermore, the MSD equation that was applied in my article should read:

$$MSD = \sqrt{\frac{\sum_{i=1}^{N}(y_i - x_i)^2}{N}}$$

This term is essentially a measure of the RMS error between calculated (y_i) and observed (x_i) conductivities. It should be distinguished from the MSD term used in Brodie *et al.*, 2003 defined according to:

$$MSD = \sqrt{\frac{\sum_{i=1}^{N}\left((y_i - x_i) - \left(\frac{\sum_{i=1}^{N}(y_i - x_i)}{N}\right)\right)^2}{N-1}}$$

Ross and Richard are thanked for bringing this to my attention.

Brodie, R., Lane, R., and Gibson, D., 2003, Gilmore Project, Comparison of AEM and Borehole Conductivity Data: Report prepared for CRCLEME, June 2002.

Lane, R., Heislers, D., and McDonald, P., 2001, Filling in the gaps—validation and integration of airborne EM data with surface and subsurface observations for catchment management—an example from Bendigo, Victoria, Australia: Expl. Geophys., 32, 205–215.

Anthony Christensen
Geological Survey of Victoria

The Geoscience Australia Information Management Strategic Plan 2003-08

Paul Trezise
Chief Information Officer
Geoscience Australia
Email:
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Introduction

When CEO Neil Williams unveiled the new Geoscience Australia Strategic Plan in December 2002 he flagged a significant change in the way the organisation viewed its role. The new Geoscience Australia vision—*to be a world leader in generating and delivering national geoscience information and knowledge*—put management of our information and knowledge squarely at the centre of the agency's strategic agenda.

The importance of information management had previously been recognised by the Geoscience Australia Executive Board through its decision to create a Corporate Information Management and Access group (CIMA) in early 2002. This was the first significant structural change to follow the formation of Geoscience Australia from the merger of AGSO and AUSLIG in October 2001.

CIMA consists of around 50 staff who formerly worked in several different Geoscience Australia divisions. It is headed by the Chief Information Officer who reports directly to the CEO and sits on the Executive Board. This change signalled a desire by Geoscience Australia to adopt a more structured and corporate approach to information management.

The Information Management Strategic Plan

An important early task for CIMA was the development of an Information Management Strategic Plan with a 3-5 year time horizon. The Executive Board required a plan that set a vision for information management within Geoscience Australia but that also included a practical road map for the journey towards that vision. The Board agreed that the objectives of the plan should be to:

- Provide strategies to ensure the best possible use of Geoscience Australia's information resource within the organisation in support of decision making, science and other operational activities;
- Provide strategies to ensure that Geoscience Australia's information is managed in a way that makes it widely accessible and useful to external stakeholders;
- Provide a framework for CIMA to develop more detailed operational policies and standards for information management within Geoscience Australia;
- Provide a framework for the strategic development of Geoscience Australia's Information Technology infrastructure; and
- Provide a framework for operational divisions to develop their own more detailed information management strategies in the knowledge that they fit within an organisation-wide umbrella.

In February 2003 CIMA engaged *Opticon Australia* to assist with the development of the plan. Opticon's role was to facilitate the internal consultation process and to provide independent advice on proposed information management strategies. It was agreed that the plan be constructed along the lines of:

- *Where we are now* - an assessment of current strengths and weaknesses and the key issues that arise from these;
- *Where we want to be* - a vision for information management in Geoscience Australia; and
- *How we will get there* - the blueprint for change, comprising a series of prioritised initiatives extending over the next three years.

Where we are now

Geoscience Australia's staff believe that our information management environment has many strengths. These include the standardisation on a small number of major application systems, the design, development and web-enablement of *Oracle* databases, the move to seamless spatial database design, and the development of some excellent visualisation tools. Despite these achievements, the internal perception is that there is considerable scope for improvements in efficiency and effectiveness.

Specific issues identified as needing attention included improving the governance framework for priority setting and resource commitment, achieving a closer engagement with Australian Government information management initiatives, improving the integration of our data and systems, achieving interoperability with relevant external systems, improving the management of our vast information archives and institutionalising information management as a standard business practice throughout the organisation.

Where we want to be

Our vision for information management within Geoscience Australia is:

Geoscience Australia's information and knowledge resource is recognised as its key strategic business asset and is:

- Generated and managed for the long term;
- Assured to a quality that matches stakeholder requirements;
- Easily discoverable;
- Readily and flexibly accessible; and
- Designed for ready integration with other resources.

How we will get there

Geoscience Australia will work towards our vision for information management through a series of prioritised and targeted initiatives. These form a blueprint for the way forward. The initiatives are grouped under 13 goals within the categories of People, Process, Technology and Performance.

People

- Improve the breadth and depth of skills accessible to support IM
- Improve the governance arrangements for IM
- Create a shared understanding of the role that IM plays
- Institutionalise IM as a standard part of business practice within projects.

Process

- Improve management of major information archives
- Implement a coherent, robust, whole-of-agency investment approval mechanism for IM projects and infrastructure
- Position the agency as a world leader in geoscience information integration
- Ensure our information and knowledge is discoverable and accessible in a controlled, flexible and timely manner
- Put in place robust policies that govern the release and usage of our information and knowledge.

Technology

- Implement a technology framework that provides a sound foundation for future development
- Ensure we have good prior visibility of technology developments that may prove relevant to future business directions

Performance

- Ensure that appropriate metrics are in place to demonstrate the cost and value impacts of IM initiatives across the agency
- Improve the implementation record of IM initiatives

A large number of specific initiatives were proposed under this framework and subsequently endorsed by the Executive Board. The most significant is the decision to adopt an 'Enterprise Architecture' approach as a method of defining and refining the corporate technology infrastructure. Enterprise Architecture is a proven methodology that is being used effectively by a many leading organisations to ensure alignment between business and technology strategies, and to establish a sound platform for business agility. Geoscience Australia has recently appointed its first enterprise architect and work has commenced on developing the baseline architecture framework.

Another important initiative involves Geoscience Australia increasing its efforts in supporting the development of geoscience and geospatial standards. This is in recognition of the vital role standards development is playing in facilitating the discoverability, access and interoperability of information. As a result GA has upgraded its membership of the Open GIS Consortium (OGC) to Technical Committee level and has established the new position of Standards Coordinator to support the participation of Geoscience Australia staff in standards development activities.

Federated Model

An important part of our approach will be a 'federated' governance model. This means that rather than exclusively relying on centralised processes we will adopt a coordinated, complementary and cooperative approach between the divisional and corporate entities in order to achieve our information management vision. Initial assignment of responsibilities has been agreed between CIMA, the 3 Divisions and the Corporate ICT Section, and an Information Management Reference Group has been established. The model will be developed further during 2004.

Conclusion

Sound information management is critical to Geoscience Australia's success. The establishment of CIMA and the development of an Information Management Strategic Plan are important steps towards achieving this end. The plan will be further developed during 2004 along with the establishment of the Enterprise Architecture framework.

Geoscience Australia Data Delivery System — GADDS

Geoscience Australia is now web-delivering data from the airborne geophysics and gravity databases using Intrepid Geophysics' JetStream data serving software.

The main features of GADDS are:

1. Data are requested using a standard web-browser.
2. Only the data required by the client are delivered to the client.
3. The format (ASCII columns or Intrepid Database) for data delivery can be chosen as well as the required datum and projection.

Both vector (line and point) and raster (grid) datasets are delivered to the user.

Datasets are selected in a simple four step process:

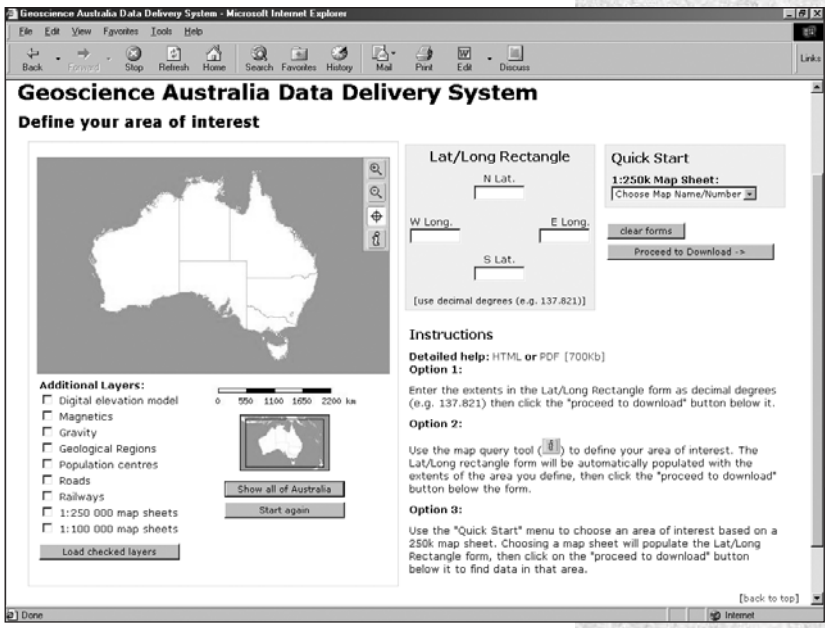
1. Define the area of interest on a map of Australia.
2. Choose the data types (magnetics, radiometrics, elevation or gravity) and theme (raster or vector).
3. Choose the dataset of interest and the dataset columns required.
4. Supply your e-mail address for delivery of the data.

For raster data files either the entire dataset or a sub-sampled (every 2nd or every 10th cell) dataset can be supplied. Users can also preview a colour image of the required dataset prior to downloading the dataset.

For vector data files selected for download the dataset is supplied at the full dataset resolution. The columns required from each vector dataset are selected by clicking on the corresponding check box. All check boxes are left unchecked if all fields are required.

Datasets meeting the selection criteria are ordered in decreasing order of data file size. A percentage coverage estimate is given to indicate how much of the chosen dataset is in the region of interest.

Other features of the data delivery interface are the survey extents and survey metadata links. The survey extents link displays a map of the full extents of the chosen survey relative to the extents of the area of interest entered by the user. The survey metadata link performs a real time query of the airborne metadata database and displays all available survey metadata relating to the chosen survey.



An estimate of the unzipped data file size and the estimated time to complete the request is also displayed. A warning is displayed if the size of the requested dataset(s) is greater than 200 Mb as files larger than this threshold could take a long time to download on a slow internet connection.

Data for individual surveys usually cover one or more 1:250,000 Sheet areas. Prior to 1990 most of the surveys had a flight line spacing of 1,500 m or more and many were conducted as part of the Bureau of Mineral Resources (Geoscience Australia's predecessor) first pass airborne geophysical reconnaissance of Australia. From 1990 surveys have usually been conducted employing flight line spacings of 400 m or less.

For further information on GADDS try out the system on the website: http://www.ga.gov.au/gadds or contact Murray Richardson via e-mail (murray.richardson@ga.gov.au) or telephone (02) 6249 9229.

Gawler Craton and Curnamona Province Deep Crustal Seismic Profiles

The Minerals and Energy Division, PIRSA and Geoscience Australia (GA) in association with the Australian National Seismic Imaging Resource (ANSIR) and the Predictive Minerals Discovery Cooperative Research Centre have recently acquired regional deep seismic reflection data within the Gawler Craton and Curnamona Province of South Australia.

The broad aims of the program are to carry out deep crustal profiling to determine a structural relationship

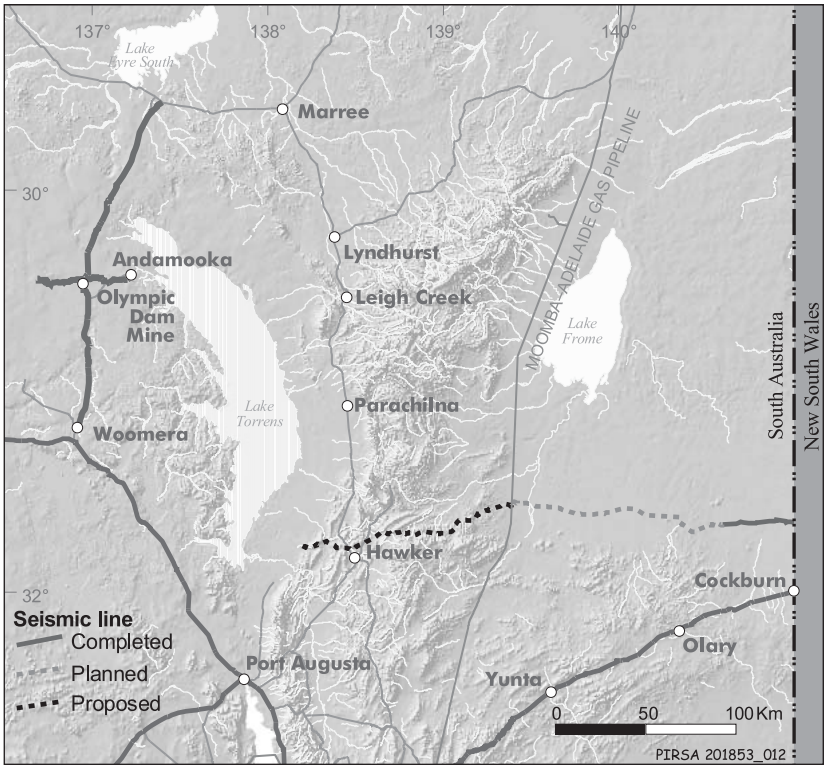


Fig. 1. Location of the completed seismic lines and the planned extension.

Fig. 2. The source Vibroseis trucks operating on the Woomera to Roxby Downs road.

between the Gawler Craton and the Curnamona Province to aid in developing a metallogenic model for the Olympic Dam Cu-Au-U deposit.

Although the application of the seismic method is normally the domain of the petroleum industry, the deep crustal profiling method has been successfully utilised by GA and the minerals industry in regions such as: the Yilgarn Craton (WA), Mt Isa District (QLD), Batten Trough (NT) and the Broken Hill Province (NSW).

The Gawler Craton seismic project consisted of two seismic traverses, a 192 km regional N-S seismic line and a 57 km E-W cross line (Figure 1). Both lines were focused on the world-class Olympic Dam mine

The line on the Curnamona Province was planned to be 165 km long, E-W orientated, with the possibility of extension to 300 km in length (Figure 1). The line extended westwards from the 1996 acquired Broken Hill seismic transect. However due to extensive rainfall the survey was stopped after only 40 km of line-data were recorded.

The seismic lines in both areas utilised existing roads or station tracks, to minimise environmental impacts.

Seismic data were acquired using three IVI Hemi 60 seismic Vibroseis trucks (Figure 2) inputting three sweeps of variable frequency signal with frequencies ranging from 6Hz to 120Hz. The field geometry consisted of 80 m source intervals and a 40 m receiver trace interval. Recording comprised 240 channels each consisting of 12 geophones distributed over a 40 m interval. 60-fold common depth point acquisition was therefore obtained for all lines. Data were recorded on an ARAM24 seismic reflection system with an 18 s period per sweep.

Processing of the data collected will take up to12 months; however the initial brute stacked sections show large scale structures and an abundance of good quality reflectors. These will result in a very interesting data set that will go a long way towards interpretation of deep geological structures in these two key areas of South Australia.

Subject to available funding PIRSA is investigating the possibility of completing the Curnamona line in the near future.

For further information please contact: Tim Barton, Geoscience Australia (Tel: 02 62499111) or Andrew Shearer, PIRSA (Tel: 08 84633045).

Isostatic Correction of the Gravity Map of New South Wales

Ross Spencer
NSW Department of Mineral Resources
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Introduction

Bouguer gravity anomaly data values for New South Wales display a number of prominent broad features (Figure 1). The strongest of these is along the coastal zone where the Bouguer gravity values rise steeply as the coastline is approached. Immediately to the west of this steep coastal gradient is a belt of low Bouguer gravity values that are coincident with the mountains of the Great Dividing Range.

Strong correlation of Bouguer anomalies with topography over broad areas is a well-known phenomenon. This phenomenon is explained by the principle of Isostasy. Since the Earth's crustal material does not have the strength to support the weight of a broad mountainous area on a molten mantle, the principle of isostasy provides an explanation of how the Earth's mountainous areas are supported.

Simpson *et al*., (1983) state that, "the compensating masses (isostatic 'roots') which support topographic loads produce large amplitude, long wavelength anomalies on Bouguer gravity maps. These anomalies, which are inversely correlated with regional topography, greatly obscure the shorter wavelength anomalies caused by bodies of geological interest. Quantitative modelling of these short wavelength anomalies also becomes difficult in the presence of the topography related regional field." Therefore, a method of extracting these effects from gravity maps is desirable, particularly when the relationship of upper crustal elements to one another is of interest.

New South Wales contains significant areas of elevated topography. Application of an isostatic correction is therefore necessary so that the calculated Bouguer gravity data are due to sources within the crust and not the Airy Heiskanen root.

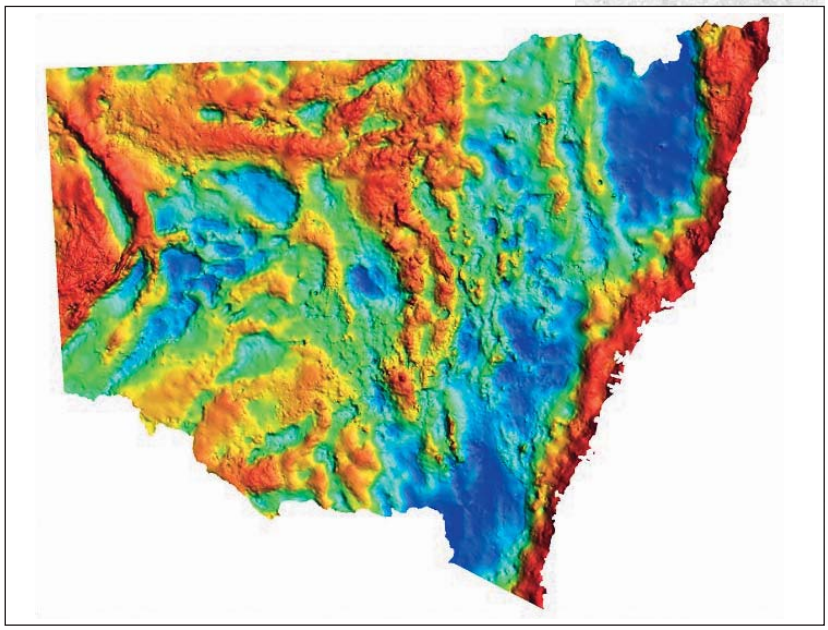


Fig. 1. Bouguer gravity image of New South Wales. Gravity data generated from Australian National Gravity Database 2003 published by Geoscience Australia.

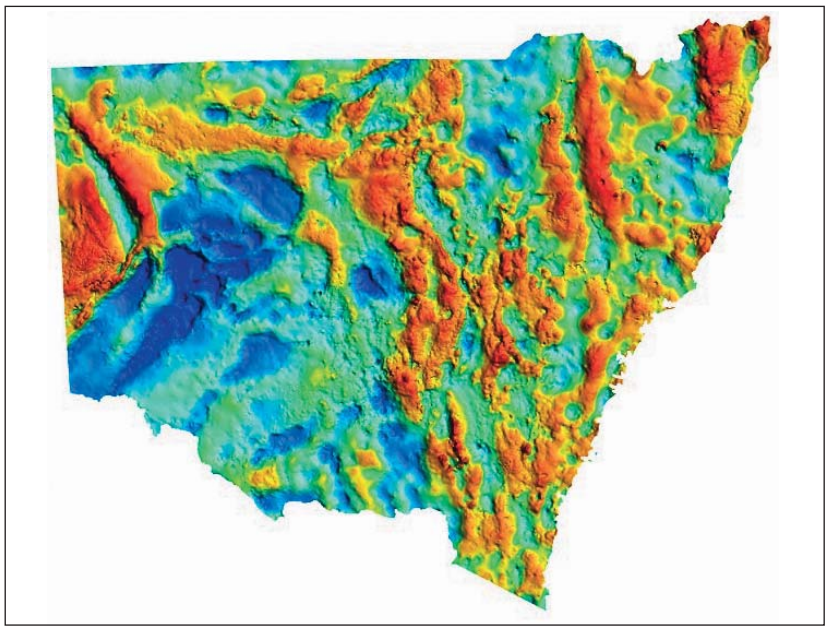


Fig. 2. Bouguer gravity data of New South Wales after isostatic correction is applied.

Results

An isostatic correction grid is produced from topography and calculated isostatic roots using a program named Airyroot. This grid is added to the Bouguer gravity grid and an isostatically corrected gravity grid is then produced. The Bouguer gravity data after isostatic correction is applied are shown in Figure 2. Clearly the steep coastal gradient has disappeared and the large belt of low values west of the coast is also no longer present. Large gravity highs in the Sydney Basin allude to higher density bodies at depth.

Conclusions

The image in Figure 2 is clearly different from the uncorrected data in Figure 1. The relationship of anomalies to one another has changed and the continuity of some features is greater. As expected the largest changes resulting from the correction occur along the coastal zone where the isostatic effects are most pronounced, due to the dual factors of the large compensation for the mountain range and the steep coastal gradient arising because of the thinning of the crust off the coast.

Careers for Women in Geoscience

In the last century

One of the important issues we face as a professional society is that of promoting the professional development of women in the geosciences and recognising their achievements.

The scientific establishments have not always done the right thing as far as female contributions are concerned. In 1962, for example, Francis Crick, James Watson, and Maurice Wilkins received the Nobel Prize for determining the molecular structure of DNA. However, the crucial work by Rosalind Franklin in producing the X-ray photographs of DNA was somehow overlooked.

In Astronomy, Cecilia Payne calculated, in her 1925 PhD thesis, that hydrogen and helium made up 98% of the mass of the sun. However, the influential astronomer Henry Russell attacked her findings saying that they were "clearly impossible" until in 1929 he published his paper supporting these results and essentially reaped the rewards.

Even Madame Curie, despite receiving two Nobel Prizes, was never admitted to the French *Academie des Sciences*.

In the geosciences the career of Inge Lehmann, the Danish seismologist, was perhaps an exception. In 1936, she made the crucial discovery that the Earth has a small inner core. Then she 'saw' the area where earthquake waves did not pass through and reasoned that there must be an outer liquid core and an inner solid core. One year later, Lehmann was appointed to chief of the Danish Geodetic Institute's seismological department and she held that position until 1953. Her achievements were well recognised, particularly near the end of her life (she lived to be 104), but she had to contend with the difficulties of a woman entering the male-dominated world of science. She once said, "You should know how many incompetent men I had to compete with--in vain."

In the last decade

So where are we now? Are we any better off than we were in the last century?

In the US, the Association for Women Geoscientists (http://www.awg.org) has produced some interesting statistics for the period 1991–2000. It found that the percentage of women obtaining a BSc, in Earth, Atmospheric and Ocean Science, increased steadily from 29% to 40% in that period.

The proportion of women who receive an MSc is nearly the same as that receiving a Bachelor's. This indicates young women are being recruited effectively from the pool of geo-majors to a Master's program.

However, the proportion of women drops considerable from the Master's to the Doctorate degree. From 1991 to 2000 the increase of recipients was comparatively small, only rising from 22% to 31%. The problem is evidently that women are not enrolling in doctorate programs.

In Australia similar statistics are not so readily available but we still appear to be missing out on many talented people in the work place.

In Australia

The *Women Achieving in Science* conferences have had a significant influence on this issue. The 2nd National Conference on Women in Science Technology and Engineering was held recently in Sydney and what follows is a report of this meeting by Pauline Gallagher, the Assistant Secretary of the CSIRO Staff Association and leader of the organising committee for WAIS 2.

"The conference focused on reasonable expectations for women to have careers in science today; it turned out to be as much a celebration of the talents of scientific women as it was a forum for pulling apart the issue of gender imbalance in Australian science, technology, engineering and mathematics (STEM).

The conference found that women are indeed achieving in STEM, leading research programs and science policy in Australia today. Highlights of the conference included presentations from palaeontologist Pat Vickers-Rich on the value of life-long curiosity and education, animal behaviour researchers Gisela Kaplan and Lesley Rogers on passion in science, and cosmologist and popular science author Janna Levin on her personal view of a finite universe.

Women have made remarkable contributions in science education, in schools and with presenting science to the public. Secondary school teacher Debbie Irwin talked about the approaches that had given Sydney Girls High School the high rate of success its students were achieving in science subjects. Science communicator Robyn Stutchbury explained why the *Science in the Bush* program had used mainly women scientists to bring science to outback communities.

The conference found that women tend to have more of the right balance of qualities for multidisciplinary effort, partnerships and commercialisation in contemporary STEM. And women tend to inspire other women more as role models and mentors.

Yet women are doing it against the odds. The conference brought together data that challenged preconceptions of gender equity in STEM. In all areas of scientific employment in Australia, the higher up the ladder you go, the fewer women there are. Women in the sciences are less likely than their male counterparts to hold qualifications higher than a BSc. Australian Research Council data showed that women are applying less and have even lower success rates for competitive research grants than their male counterparts, even though the situation has improved on past years. A CSIRO study found that women are underrepresented or absent from the ranks of recipients of national and international scientific awards.

The conference identified a range of impediments. Women tend to carry the bulk of family responsibilities at home and to lose professional currency when they take breaks to have children. Notions of professionalism, with expectations of long hours of work and unlimited dedication to work, have driven a culture in STEM that covertly discriminates against those with career responsibilities. Women tend to be more limited in their geographic mobility which can make or break a scientific career. Relative isolation from other women at work often undermines confidence to speak up and be heard. Undervaluing of the work women do and the potential of women for new opportunities boiled down to plain discrimination.

Participants were very much aware that although the studies presented were indicative, more comprehensive research was needed to convince the decision-makers on the issue. It was a major recommendation of the conference that the government fund a proper study into how women are faring in the competition for jobs and funding in Australian STEM. The conference produced a range of further recommendations to improve the situation (see the conference report at www.cpsu-csiro.org.au). "

In the ASEG

The percentage of women office bearers on both the Federal Executive (FedEx) and on Branch Committees has significantly increased in the last few years. However, it appears that until 2002 when three women served on the FedEx, there was at most only a single female on the committee in any one year since the ASEG was established in 1971. Currently we have three women on the Fedex and four others serving as Presidents or Secretaries of our Branches. In recognition of their contributions to exploration geophysics, and the ASEG in particular, we are providing short summaries of their responsibilities and achievements.

Helen Anderson has experience in both technical and business development roles. After graduating with a BSc (Geology) from the University of Western Australia, she worked as a mine geologist at the Telfer Gold Mine. Following this, she joined World Geoscience Corporation specialising in the interpretation of airborne magnetic and electromagnetic data for mining, petroleum and environmental groups throughout the world. Helen then moved into a project generation role for Normandy Mining Ltd (now Newmont Australia), working closely with exploration teams in Australia and overseas. After completing a Masters Degree in Science and Technology Commercialisation, Helen is now employed as Manager, Business Development (Oil & Gas) for Fugro Airborne Surveys. This involves marketing the company's airborne geophysical services to the petroleum sector, as well as advising on technology commercialisation issues. Helen serves on the Federal Executive Committee and is currently on maternity leave from Fugro.

Helen Anderson

Jenny Bauer graduated from the University of Queensland in 1973 with a Bachelor of Applied Science (Geophysics). She has worked for the Bureau of Mineral Resources (now Geoscience Australia), CSR, LASMO Oil (Australia) Ltd, SAGASCO Resources and Boral Energy, initially as a geophysicist, then as Chief Geophysicist and Exploration Manager. She is currently Manager, Exploration Otway and Bass Basins for Origin Energy Resources Ltd in Brisbane, in which capacity she manages exploration programs in Origin Energy's offshore and onshore Otway and Bass basin permits, and seeks new exploration opportunities for the company in these areas. She is a member of the ASEG, the SEG and the PESA. Jenny was co-chair of the 15th Geophysical Conference and Exhibition held in Brisbane in 2001, and has served on the Federal Executive since 2002 as 2nd Vice-President.

Jenny Bauer

Kirsty Beckett is President of WA Branch of ASEG. She graduated from Curtin with a BSc (Hons) in Geophysics and started her career at World Geoscience Corporation in 1996. Her main role there involved correcting and geo-rectifying satellite data, imaging and map generation. Kirsty also applied remote sensing imaging techniques to AEM data, to identify palaeochannels and map shallow bathymetry.

Kirsty Beckett

She then moved into the research and development department of WGC, where she integrated geological, geophysical and remote sensing data to improve interpretation. After Fugro's takeover in 2000, Kirsty worked briefly with OTEK, producing reports on heavy metal and petroleum pollution in the Northern Territory. In 2001, she joined UTS as Sales, Marketing and Data Processing Manager, and assisted with the development of low-level airborne radiometrics for soil mapping. She has also been involved in conference and

Tania Dhu

course development on the use of spatial data for land management, including the Katanning 2001 Salinity and Land Management meeting, and the Perth 2003 Information for Natural Resource Management. She is a member of the TripleS - Science for School Students organising committee, encouraging school students in WA to participate in science. Kirsty is pursuing a PhD at Curtin UT on the application of magnetics and radiometrics to improve groundwater modelling.

Tania Dhu is the Secretary of the SA Branch of the ASEG. She completed a BSc at Adelaide University majoring in Geology and Geophysics in 2001. Then she started an Honour's degree in Geophysics, looking at environmental problems, specifically whether electrical resistance tomography could be used in characterising subsurface contaminant flow. On completion of her Honours she worked in Mineral Promotions at PIRSA for three months, where she promoted South Australia's mineral resources.

In April, 2003 Tania began a PhD at Adelaide University sponsored by CRC LEME. Although still defining her research topic, it will be associated with characterising groundwater flow. Through her studies she has been given the opportunity to travel and meet interesting people, and hopes to contribute in some way to furthering the protection of our important groundwater resources.

Megan Evans

Megan Evans is the WA Branch Secretary. She is employed as a geophysicist at the consulting company Total Depth Pty Ltd, which she joined in 2001. Megan obtained her BSc and Hons degrees at Curtin University, with her thesis on Time Reversal Acoustics Modelling.

Since joining Total Depth, Megan has been involved in interpretation, model based inversion, seismic consistent inversion, spectral analysis, database analysis, well log prediction, post-stack spectral enhancement and waveform classification projects on 2D/3D seismic datasets from Australia, Africa, New Zealand and the Gulf of Mexico. Megan has also created and presented training tutorials on several Australian 'open-file' 3D datasets which are used to demonstrate the use and/or application of several specialist software applications available to Total Depth. She has trained over 40 geoscientists in the use of waveform classification in courses, both in-house and in companies' offices. Although based primarily in Perth, her training and consulting projects has led to her working for companies both within and outside of Australia.

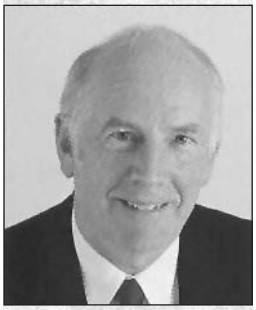
Natasha Hui

Natasha Hui is the Secretary of the Queensland Branch of the ASEG. She works as a Graduate Geophysicist in the Exploration Department of the Northern Business Unit at Santos, Brisbane. Her work has included geophysical interpretations on Santos Cooper Basin and Bowen Basin assets. This has involved structural mapping and seismic modelling of hydrocarbon prospects and conducting regional studies on both 2D and 3D seismic data. Natasha holds a BSc (Honours) in Geoscience and a BEng from the Queensland University of Technology. She is currently undertaking a Post Graduate Diploma of Mineral Resources Exploration at the University of Queensland.

Lisa Vella

Lisa Vella graduated from the University of Sydney with Honours in Geophysics in 1991. After two years with Newcrest Mining Ltd., working at the Telfer and Tuckabianna gold mines, she started work with WMC Resources Lisa spent almost three years working at Hill 50 Gold Mine, before transferring to Melbourne to work in WMC's Africa/Eurasia group, focusing on exploration in West and East Africa and Kazakhstan. Transferring to Perth in early 1998, Lisa spent two years working in the Global Project Generation team, focusing mainly on reconnaissance exploration for nickel in southern Africa, iron-oxide Cu-Au in Brazil and gold in China, as well as providing geophysical support to Three Springs Talc Mine. Since early 2000, Lisa has been involved in managing reconnaissance Au and Ni exploration projects in China, and more recently, contributing to exploration programs in Australia, North America and Africa. She is the ASEG's Honorary Secretary.

The Shuttle Radar Topography Mission — A new source of near-global digital elevation data



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Abstract

The Shuttle Radar Topography Mission (SRTM) has generated a homogeneous near-global digital elevation model (DEM) of the Earth using single pass radar interferometry. The crew of Space Shuttle Endeavour (STS-99) operated the modified dual antenna synthetic aperture radar systems for 11 days in February 2000. SRTM acquired both C-band and X-band synthetic aperture radar data, collecting 3D data using a 60 m mast extending from the shuttle payload bay, containing additional C-band and X-band receiver antennas.

SRTM DEM data have a horizontal resolution of 1 arc second (30 m at the equator) and a vertical resolution of 10 m (C-band radar). The USGS are responsible for archiving the data with the 3 arc second data available on a continent by continent basis. So far North and South America have been completed and the rest of the data processing is expected to be complete by July 2004. Comparison of SRTM DEM data with older GTOPO DEMs shows a significant improvement in resolution. The SRTM DEM data provide a useful new resource, especially in areas where limited topographic data are available.

Shuttle Radar Topography Mission

The Shuttle Radar Topography Mission (SRTM) was a collaborative mission by the National Aeronautics and Space Administration (NASA), the National Imagery and Mapping Agency (NIMA) of the US Department of Defense, the German Space Agency (DLR) and the Italian Space Agency (ASI). The project, managed by NASA's Jet Propulsion Laboratory, Pasadena, California, was designed to generate a near-global digital elevation model (DEM) of the Earth using single pass radar interferometry. The SRTM data were acquired between 11-22 February, 2000 on STS-99 (Space Shuttle Endeavour) and 12 terabytes of raw data were acquired, which are currently being processed into digital elevation.

SRTM uses a technique called radar interferometry, in which two radar images are taken from slightly different locations. Differences between these images allow for the calculation of surface elevation, or change. To get two radar images taken from different locations the SRTM hardware consisted of one set of radar antennas in the shuttle payload bay and a second set of radar antennas attached to the end of a mast that extended 60 m from the shuttle (Figure 1).

SRTM was launched into an orbit at 233 km with an inclination of 57°. The C-band radar (SIR-C) developed by

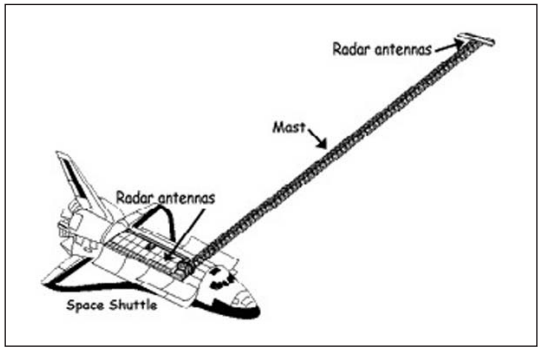

Fig. 1. The SRTM dual radar antenna setup on the Shuttle spacecraft.

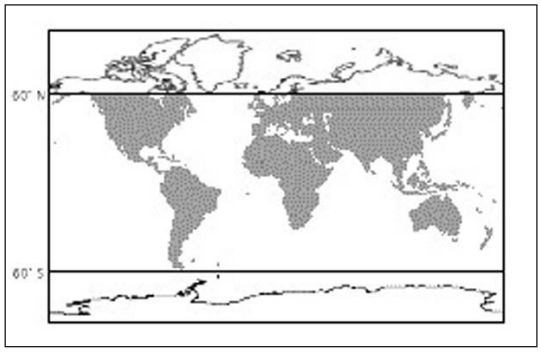

Fig. 2. SRTM near global coverage of landmass from 60°N to 56°S.

NASA operates at a frequency of 5.6 GHz with active steering of the radar beam to give a variable look angle painting a much wider swath than in fixed operation. SIR-C acquires data with a 225 km wide swath which allowed the SRTM C-band radar to cover most of Earth's land surface that lies between 60° north and 56° south latitude, about 80% of Earth's land mass (Figure 2).

Ideally each terrain segment is imaged at least twice from different angles (ascending and descending orbits) to fill in areas shadowed from the radar beam by high relief terrain. SRTM provided 94.6% of imaged landmass covered at least twice and 50% three or more times. The X-band radar (X-SAR), provided by DLR/ASI operates at a frequency of 9.6 GHz with fixed scan so covers only a 50 km swath but has vertical resolution better than 6 m. Details of the mission can be found in the STS-99 Press Kit (NASA, 2000) and Farr and Kobrick (2001).

JPL have completed basic processing of the interferometry information and passed on an unedited DEM to NIMA who will clean up the data. Users should be aware that the preliminary data may contain voids and spikes, and water surfaces and coastlines are not well defined because of low radar backscatter. The USGS EROS data centre is archiving

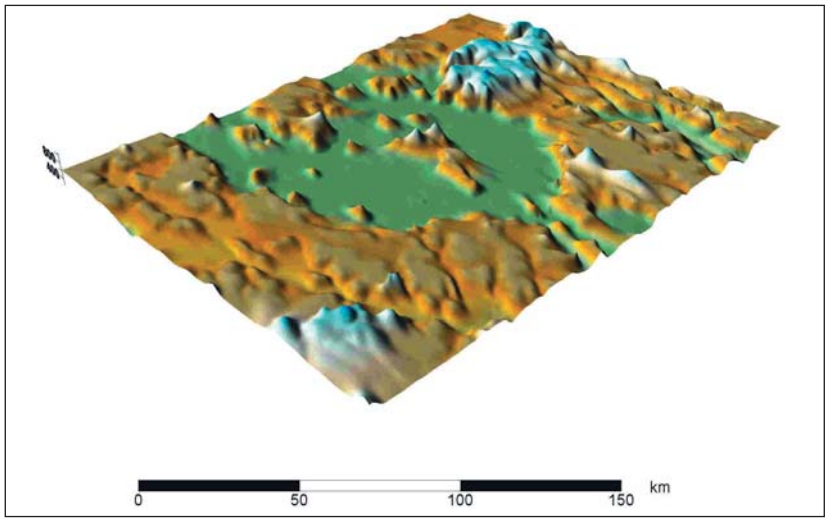

Fig. 3. GTOPO30 DEM for the Manicouagan impact structure, Quebec, Canada. Cell size is 30 arc seconds, about 810 m, and the viewing direction is looking northeast.

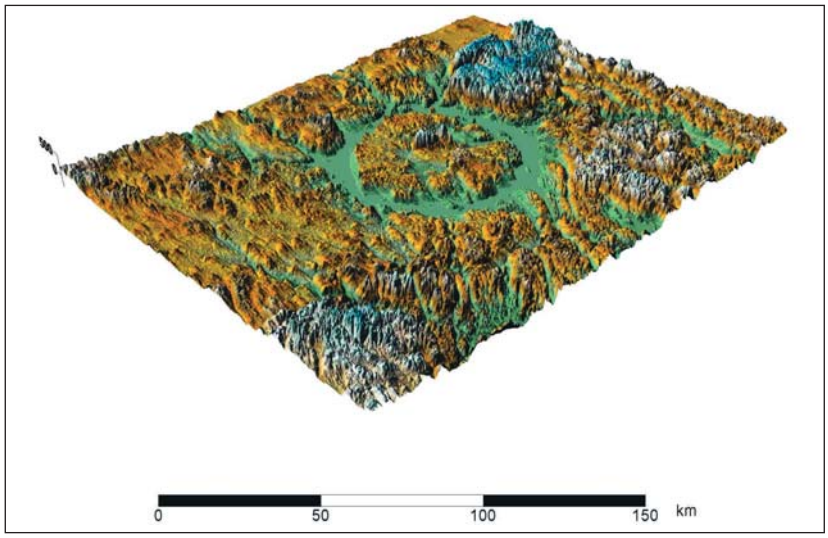

Fig. 4. SRTM DEM for the Manicouagan impact structure, Quebec, Canada. Cell size is 3 arc seconds, about 90 m, and the viewing direction is looking northeast.

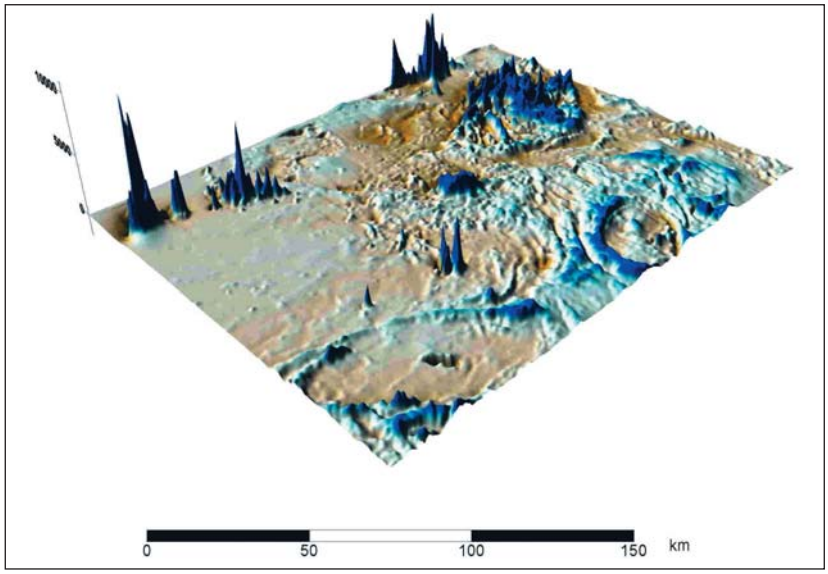

Fig. 5. 3D aeromagnetic image of the Manicouagan impact structure, Quebec, Canada. Cell size is 400 m and the viewing direction is looking northeast.

the data on their website on a continent by continent basis but only at 3 arc second resolution (SRTM-3) outside US territory. So far North and South America are on the website. The rest are due to be completed by July 2004. Data are archived in 1°x1° sheets involving approximately 14,300 cells. The 3 arc second data are produced by averaging 1 arc second data, reducing some of the radar speckle in the process. A tile of data covers 1°x1° consisting of 1201 lines by 1201 samples as 16 bit binary referenced to the bottom-left. The website is ftp:/edcsgsa.cr.usgs.gov/pub/data/srtm. The resulting digital topographic map is a homogeneous data set referenced to a uniform global geodetic datum.

SRTM and GTOPO30 comparison

Figures 3 and 4 show a comparison of 3D DEM images of GTOPO30 and SRTM-3 data over the Manicouagan impact structure in Quebec, Canada. In Figure 3, the old GTOPO provide limited expression of the impact structure showing a vague circular topographic low corresponding to Manicouagan.

In Figure 4, the improved resolution of the SRTM-3 data is impressive. Lake Manicouagan, the large annular lake in these images represents the remnants of one of the largest impact craters still preserved on the surface of the Earth. Lake Manicouagan surrounds the central uplift of the impact structure, which is about 70 km in diameter and is composed of impact-brecciated rock surrounded by erosion-resistant metamorphic and igneous rocks. Glaciation and other erosional processes have reduced the extent of the crater, with the original diameter estimated at about 100 km. The impact that formed Manicouagan is thought to have occurred about 212 million years ago, toward the end of the Triassic period.

Figure 5 shows a 3D image of the Manicouagan aeromagnetic data. The aeromagnetic data show a relatively subdued circular anomaly with a rugose texture over the central uplift. A small higher amplitude magnetic anomaly seen in the centre of the central uplift corresponds to a topographic high.

The combination of aeromagnetic and SRTM data provides an excellent tool for recognising impact structures.

Conclusions

The Shuttle Radar Topography Mission (SRTM) has generated a near-global digital elevation model (DEM) of the Earth using single pass radar interferometry. SRTM DEM data have a horizontal resolution of 1 arc second (30 m at the equator) and vertical resolution of 10 m (C-band radar). The 1 arc second data will only normally be available for US territory. The USGS EROS Data Centre is responsible for

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Can electromagnetics directly map the acid sulfate soil hazard in Australia?

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What are acid sulfate soils?

Some 10,000 years ago, during the last major sea level rise, sediments were rapidly deposited along the current day coast line of Australia (Harbison and Cox, 2002). Contained within these waterlogged sedimentary sequences was an abundance of bacterial species that thrived off the sulfate within the seawater and the iron in the soil. The interplay between these organisms and the iron and sulfate subsequently produced various iron sulfide compounds (Sammut and Lines-Kelly, 1996). Being formed in a water-saturated environment, these compounds are very stable in anoxic conditions. When exposed to air, however, the sulfidic sediments oxidise and produce sulfuric acid (Preda, 1999). Thus, these soils are termed Acid Sulfate Soils (ASS).

To date, discharge of sulfuric acid from ASS has caused millions of dollars of damage to the infrastructure of Australia's coastal communities through its ability to corrode concrete and steel structures (Sammut and Lines-Kelly, 1996). It also affects an additional $10 billion of coastal developments (Cribb, 1999) and is responsible for significant economic losses in the agricultural sector (Sammut and Lines-Kelly, 1996; Leadbitter, 2000). Successful management of this environmental hazard, therefore, requires early identification and remediation of ASS 'hot spots'.

Electromagnetics as a potential ASS mapping tool

Australia is not alone in the pursuit of an effective and efficient technique for mapping ASS potential. The Geological Survey of Finland (GTK) is also investigating methods for rapidly but accurately identifying its country's ASS hazard (Palko, 1994). Working on the theory that the sulfides associated with ASS are considered relatively conductive, the GTK are currently trialling electromagnetic methods to map their lateral distribution and depth extent (Puranen *et al*., 1999). It was thought that a similar approach could be applied in Australia (Brodie *et al*., 2002). A collaborative research project between Geoscience Australia and the Queensland Acid Sulfate Soils Investigation Team (QASSIT, based at the Queensland Department of Natural Resources and Mines), therefore, was established to evaluate the effectiveness of electromagnetic techniques for mapping the potential acid sulfate hazard of Australian soils.

The Pimpama region within the City of the Gold Coast (Queensland) was chosen for this pilot project as, in addition to QASSIT's extensive knowledge of the area, the region exhibited the complete spectrum of ASS potential—from none to very high. Where sulfides were present, they were interpreted as discrete, narrow (~2-4 m thick) horizontal layers, the top of which are within a few metres of the surface (Queensland Department of Natural Resources and Mines, 2002). The percentages of sulfide contained in the soil even, in areas interpreted as having 'high' ASS potential, however, rarely exceeded 1% within these layers.

Four traverses were planned for this study - one each over an area interpreted as having 'high', 'moderate', 'low' and 'no' ASS potential. The electromagnetic data were acquired using Zonge's NanoTEM® technology as this system allows good resolution of conductivity variation in the upper five metres of the earth (eg Hatch *et al*., 2002). Specifications for the NanoTEM® survey included a 2.5 x 2.5 m receiver loop (sampling 31 windows between 0.5 µ and 1.0 ms) centrally located within a 10 x 10 m transmitter coil. The station spacing between receiver locations along each traverse was also 10 m.

Do acid sulfate soils have an electromagnetic signature?

Initial results from the electromagnetic survey indicated that there was a clearly defined conductivity layer between the depths of 2 and 6 m in the area of 'high' ASS potential (Figure 1). And that the amplitude of this anomaly decreased with decreasing (interpreted) ASS potential (cf. Figures 1, 2, 3, and 4). Results from borehole conductivity logging along these traverses confirmed that these conductive sources, predicted from inversion of the NanoTEM® survey, were real and correlated to recognisable layers within the soil profile.

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archiving the data with 3 arc second data being made available on a continent by continent basis and so far North and South America have been completed. Data processing is expected to be complete by July 2004. Comparison of SRTM DEM data with older GTOPO DEMs shows a significant improvement in resolution. The SRTM DEM data provide a useful new resource especially in areas where limited topographic data are available.

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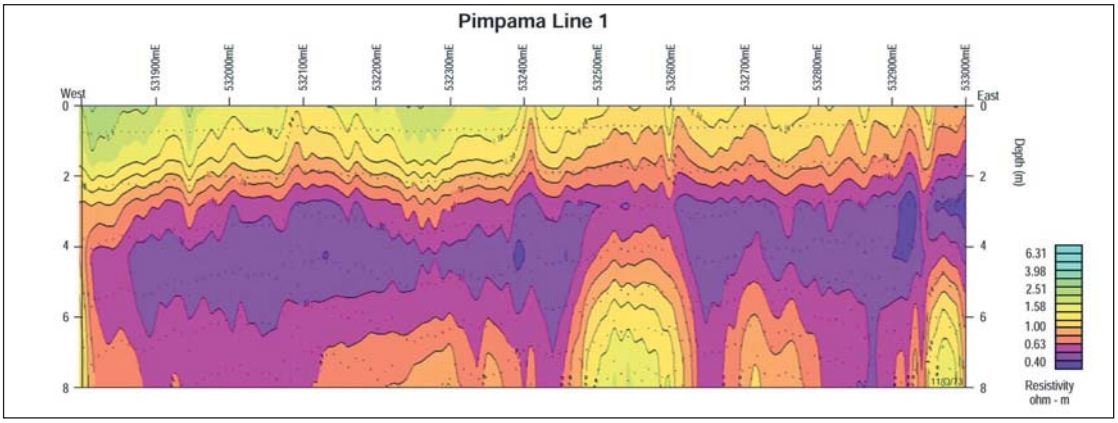

Fig. 1. NanoTEM® conductivity pseudo-section of Line 1. This traverse was conducted over an area within the Pimpama study area interpreted as having a high ASS potential. Note that conductivity is the reciprocal of resistivity.

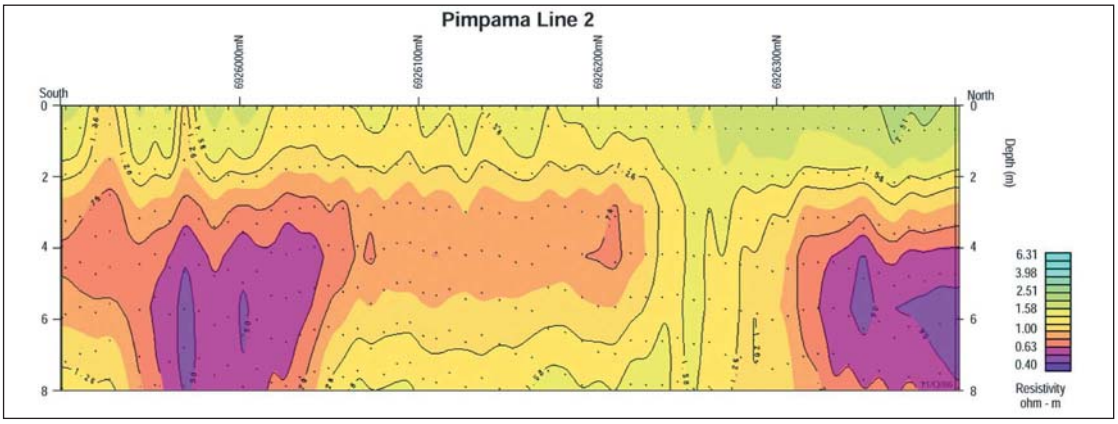

Fig. 2. NanoTEM® conductivity pseudo-section of Line 2. This traverse was conducted over an area within the Pimpama study area interpreted as having a moderate ASS potential.

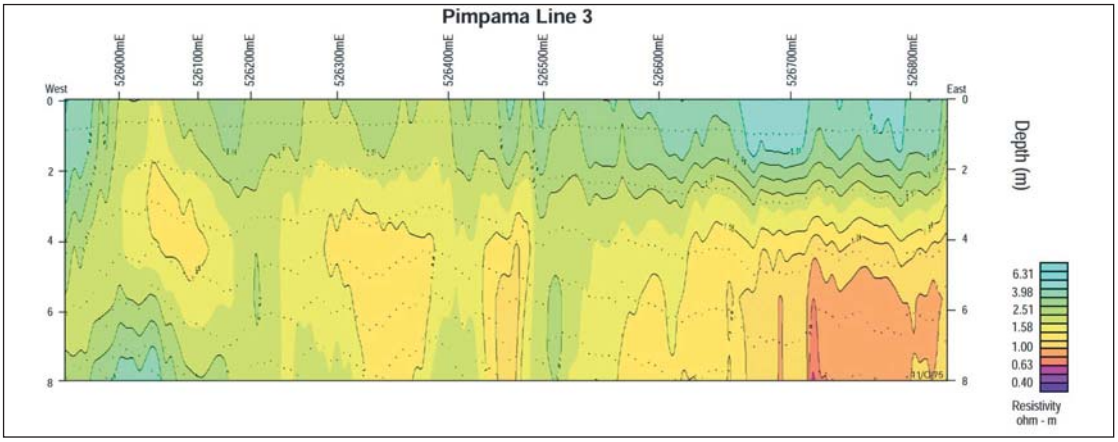

Fig. 3. NanoTEM® conductivity pseudo-section of Line 3. This traverse was conducted over an area within the Pimpama study area interpreted as having a low ASS potential.

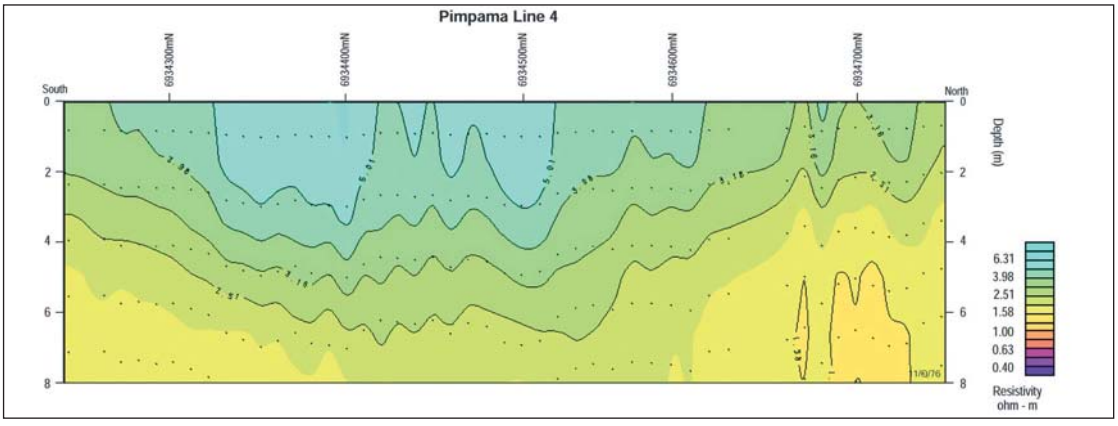

Fig. 4. NanoTEM® conductivity pseudo-section of Line 4. This traverse was conducted over an area within the Pimpama study area interpreted as having no ASS potential.

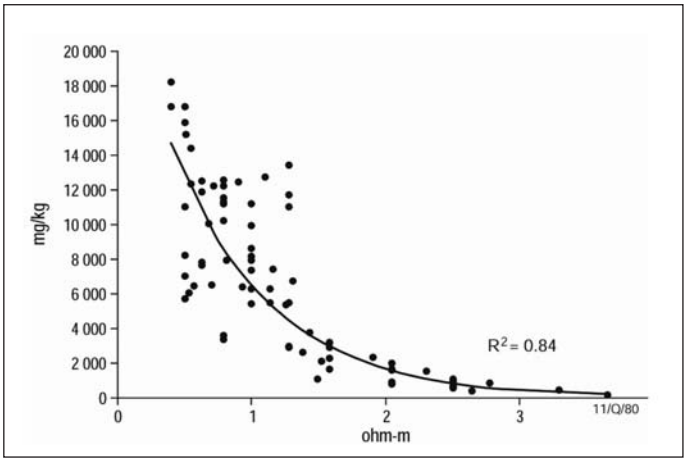

Fig. 5. Scatter plot of NanoTEM® resistivity (ohm-m; the inverse of conductivity) and concentration of soluble chloride (mg/kg) as measured in boreholes along the NanoTEM® traverses. The R-squared value of 0.84 indicates that the relationship between the quantity of soluble chloride present in the soil and the electrical conductivity is very strong. (An R-squared value of 0.84 implies that variations in the soluble chloride concentration explain 84% of the variation in the NanoTEM® response).

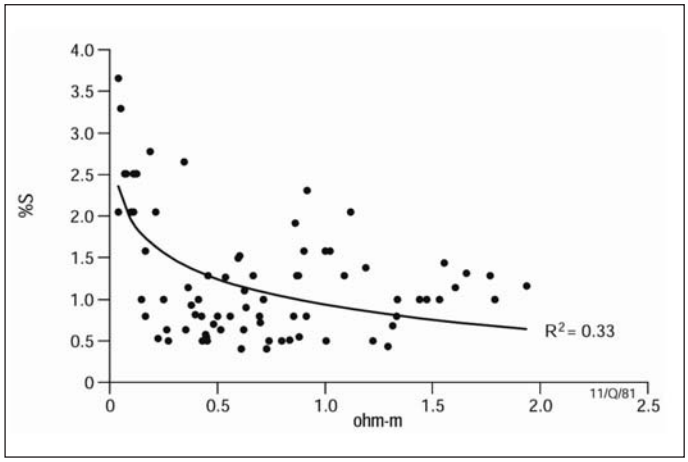

Fig. 6. Scatter plot of NanoTEM® resistivity and potential acidity (the percentage of sulfide present in the soil). The resulting R-squared value of around 0.33 irrespective of the trend/regression type applied suggests there is little, if any, relationship between the electrical conductivity and sulfide content in the Pimpama study area.

The presence of iron sulfides, however, is not the only explanation for this conductive layer. Variations in groundwater salinity, soil porosity and soil composition between traverses could also explain the differences in the conductivity profiles (Barrett et al., 2002). Consequently, the electromagnetic anomalies were compared against the properties of composition, concentration of groundwater salinity and amount of iron pyrite in the soil.

A regression plot of the aforementioned variables and the corresponding NanoTEM® resistivity values (Figure 5) subsequently indicated that, with an R-squared value of 0.84, saline porewaters are probably the main factor controlling the electrical conductivity response in the Pimpama study area. Equally, the lack of correlation between potential acidity, or percent sulfides, and electrical conductivity (Figure 6) suggests that there is not a direct relationship between the interpreted potential ASS hazard and its electromagnetic response.

Electromagnetic techniques, thus, do not appear to be an effective tool for ***directly*** mapping the acid sulfate soil hazard of saline Australian soils. The Finnish research (Puranen *et al*., 1999) reached a similar conclusion, and demonstrated that groundwater salinity and pore water content are the main determinants of an area's electrical conductivity.

Acknowledgements

The author greatly appreciates the support of the Queensland Acid Sulfate Soils Investigation Team, in particular Col Ahern and Jeremy Manders, as without their assistance this pilot study would not have been possible. Similarly, Ian Lambert and Ross Brodie of Geoscience Australia were crucial in ensuring this project got off the ground and provided invaluable support throughout the life of this research. Thanks also to Brian Minty, whose comments resulted in significant improvements in this paper.

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Fugro Airborne Surveys

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Fugro Airborne Surveys Pty Ltd was formed in 2000 through the global merger of several leading geophysical companies, specialising in the acquisition, processing and interpretation of airborne and ground geophysical data.

The company is part of the Geoscience Division of Fugro NV, a Dutch holding company whose businesses include geotechnical engineering, positioning and marine surveying. Fugro was founded in 1962, has over 250 offices, about 7000 staff and a permanent presence in more than 55 countries.

Top: Fig. 1. CASA aircraft with GEOTEM loop.

Above: Fig.2. Resolve Helicopter EM system.

Its annual turnover has risen from $357M in 1996 to $946M in 2002 and the net profits have increased correspondingly from $16M to $72M during the same period.

Fugro Airborne Surveys itself is split into specific operations to encompass all aspects of non-seismic geophysical service requirements:

Airborne Geophysics (Fugro Airborne Surveys)
Ground Geophysics (Fugro Ground Geophysics)
Instrument Sales and Rentals (Fugro Instruments)

Airborne Geophysics

Fugro Airborne Surveys (FAS) can lay claim to being the most comprehensive geophysical service company in the world, with the latest solutions and technologies capable of detecting and measuring a wide range of geophysical targets. The Asia-Pacific headquarters are in Perth and a regional office is located in Sydney. There are international offices in Canada and South Africa, as well as representation in many other countries. Staff numbers are approximately 400 worldwide, many of whom are geoscientists with a wealth of experience.

Familiar airborne-electromagnetics systems such as TEMPEST, GEOTEM, DIGHEM and RESOLVE are included in the FAS stable. These systems continue to prove themselves invaluable in the exploration of gold, nickel, base metals, diamonds, environmental and salinity mapping. Sophisticated inversion modelling and 3D visualisation provides the interpreter with reliable conductivity information from the surface to depths of over 600 m. Recent R&D developments include improved EM 'birds', higher power and broader bandwidth capabilities.

Airborne magnetics - the essential geophysical exploration technique, can be acquired from a number of platforms, be it single or twin engine fixed-wing or helicopter stinger and towed-bird. From highly detailed, ultra low-level to regional and offshore surveys, there is an aircraft for every environment and terrain.

Horizontal gradiometer systems are an enhancement to improve the resolution of oblique magnetic structures by directly measuring the transverse gradient.

Radiometrics are often collected concurrently, with extra crystal volume allowable on some aircraft to improve the resolution of this near-surface technique.

Airborne gravity and gravity gradiometry systems are also flown by Fugro and are increasingly used as exploration tools for both petroleum and mineral resources.

Combining geophysical systems in one platform is a cost-effective means of airborne surveying. A recent example of this is a scientific survey conducted for the Australian Antarctic Division, where a modified Twin Otter was fitted out with a gravity system, a magnetometer bird and an ice-radar. This exercise required the co-operation of Australian and international companies as well as extensive logistical planning for a smooth operation in an extreme environment.

FAS complements data acquisition with strong data processing, interpretation and R&D capabilities, which results in a complete package being available to explorers.

FAS is a founding member of the International Airborne Geophysics Safety Association (IAGSA) and has recently been accredited to comply with the ISO9001:2000 quality

standard. The company places a strong emphasis on its Safety Management System with each survey subjected to a comprehensive Risk Assessment and Job Safety Plan prior to any flying.

Ground Geophysics

Fugro Ground Geophysics (FGG) operates worldwide ground geophysical data acquisition and processing activities through its own and affiliated offices in Australia, Peru and Brazil.

Coming from a background of eminent geophysical product and service providers, FGG has in-house expertise in all geophysical techniques, and a wealth of experience in their application, in a variety of countries and environments. This expertise, together with an extensive range and volume of equipment, provides an unrivalled ability to supply crews where they are needed throughout the world, while maintaining the highest data quality and safety standards.

The company provides a large suite of high-resolution ground geophysical services for mineral, petroleum and groundwater exploration, for geological mapping, and for environmental and engineering investigations.

Last year saw the majority of work being carried out using DGPS Gravity, TEM and IP although FGG also offers CSAMT, NMR, detailed magnetics and other techniques.

DGPS Gravity

FGG has over 30 years accumulated experience in gravity data acquisition across the globe, having pioneered the use of DGPS for the accurate 3D positioning of gravity stations in 1992, and leading its development ever since.

The company operates 26 Trimble and Ashtech geodetic grade dual frequency GPS receivers, and has a stable of 13 Scintrex CG3 meters, including three ultra-high resolution CG3-M meters, and 10 La Coste & Romberg Model G meters.

Recent surveys include 4500 gravity stations covering a country in the Middle-East; 3300 stations over large areas of Belgium; 3800 stations across Peru and numerous large surveys in Australia with over 19,000 stations last year alone.

Time Domain Electromagnetics (TEM)

FGG offers a wealth of TEM experience and operates SMARTem, Protem, Sirotem and Zonge TEM systems, with a full range of transmitter sizes, coil selections and down-hole probes.

Recent developments include B Field sensors for the detection of super conductive orebodies. These are now being used routinely in ground TEM surveys.

IP and Resistivity

The company provides IP crews across the globe using Scintrex, Zonge and Iris equipment with a full range of transmitters from 250W to 30kVA.

FGG has been at the forefront of the development of high-resolution 3D IP surveys. This surveying technique allows the generation of detailed geometric information on the anomaly source.

The company was the first organisation accredited by the WA Dept of Consumer and Employment Protection, authorising high-powered electrical survey work throughout WA, within the scope of its certified procedures. FGG adheres to these procedures wherever crews are working to ensure the highest standards of electrical survey safety.

Top: Fig. 3. Shrike with wingtip gradiometer sensors.

Middle: Fig. 4. Antarctica operations - Twin Otter.

Above: Fig. 5. Helicopter gravity operations.

Instrument Sales and Rentals

Fugro Instruments (FI) is a leading provider of innovative geoscientific solutions for land, marine and airborne environments. Based in Sydney, the company also has a worldwide network of representative offices that assist on a local level and provide a strong customer support for geophysical instrument sales, rentals, servicing and manufacturing.

Fugro Instruments has an established background in the servicing and repairs of all types of land, marine and airborne geophysical equipment. These technical capabilities extend to after-sales support, with every effort

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The Search for Hot Dry Rock Energy

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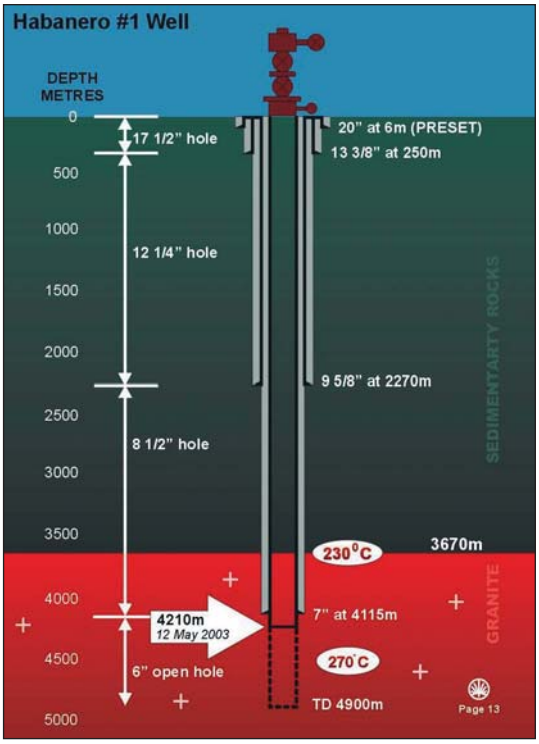
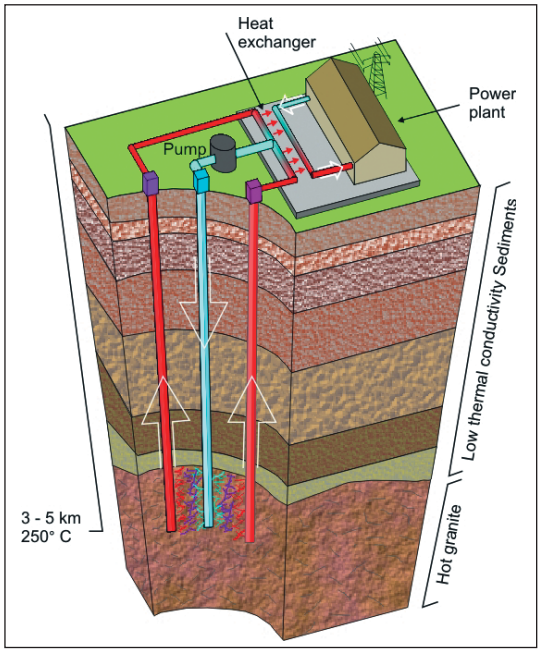
In northeastern South Australia, just south of the town of Innamincka, a 4400 m deep well called Habanero-1 has just been completed. This well is the second deepest well to have been drilled on mainland Australia (Figure 1). It is named after the Habanero Chilli of Mexico, which has been thought to be the world's hottest. Like its namesake, Habanero-1 is hot. The well passes through ~3.5 km of sediments of the Eromanga and Cooper Basins and then for a further ~900 m into a hot Carboniferous granite. At the bottom, the temperature is at least 250°C; making it Australia's hottest well.



Left: Fig. 1. Schematic diagram of Habanero-1.

Habanero-1 has been drilled by the Australian company Geodynamics Ltd, as part of an ambitious program to prove and develop Australia's unique geothermal energy resources. The program involves a process called Hot Dry Rock geothermal energy (HDR). The HDR concept was first proposed by scientists working at the Los Alamos National Laboratory in the US in the early 1970's. Since that time a conservative US$600 million has been spent globally in the attempt to turn the HDR concept into an energy reality.

The concept itself is very simple. The interior of the Earth is characterised by increasing temperature with depth—the geothermal gradient. In HDR this heat is accessed by drilling two or more wells into a hot rock mass at depth (Figure 2).



Right: Fig. 2. Cartoon of HDR power station envisaged at Habanero-1.

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being made to respond to service and repair enquiries with the fastest possible turnaround time.

An extensive range of the latest equipment is available for the following geophysical techniques and complements the airborne and ground survey activities:

Magnetics
Electromagnetics
Resistivity Imaging
Induced Polarisation (IP)
Nuclear Magnetic Resonance (NMR)
Magnetotellurics (MT)
Radiometrics
Gravity
Seismic
Ground Penetrating Radar (GPR)
Digital Core Imaging, Orientation & Storage
Borehole Logging Systems
Handheld Magnetic Susceptibility & Conductivity meters
Stand-alone & integrated Differential GPS

Together, Fugro Airborne Surveys, Fugro Ground Geophysics and Fugro Instruments have the capacity, experience and expertise to offer geophysical assistance to clients worldwide and will continue to provide solutions for all environments and situations.

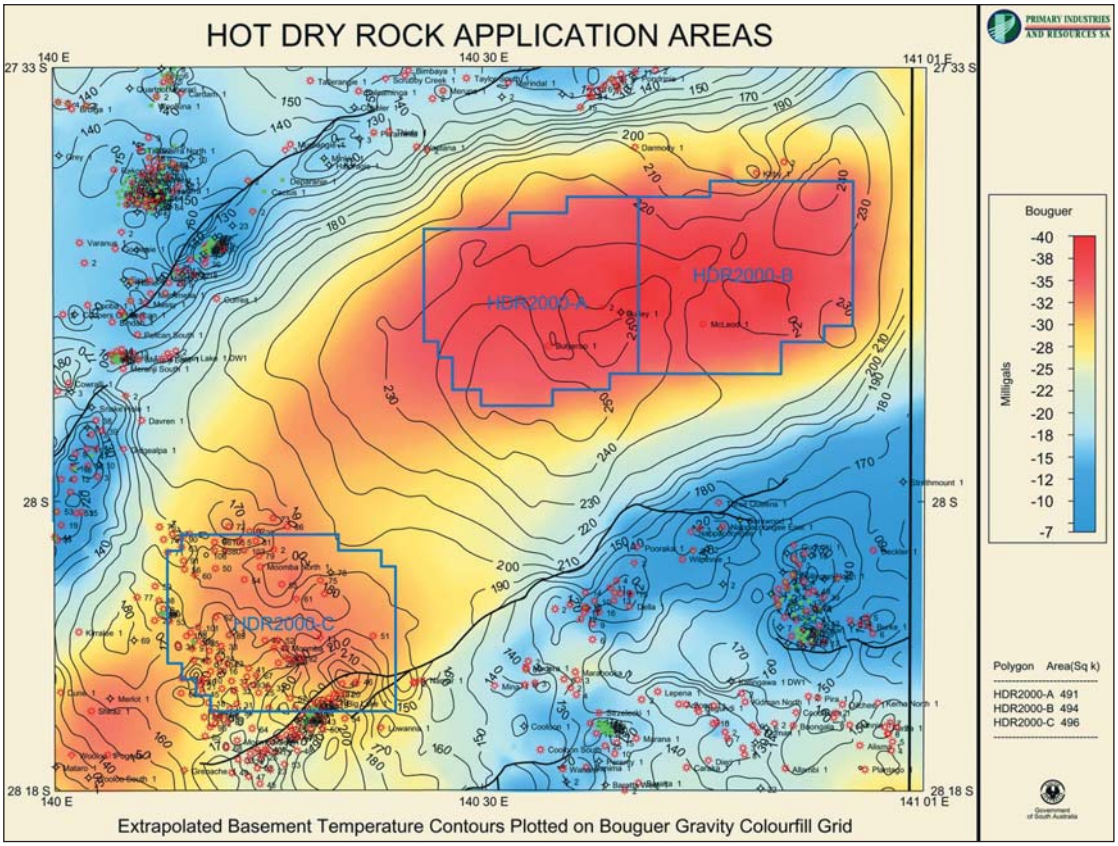

Fig. 3. Locations of HDR Exploration Leases and estimated basement temperatures plotted on to Bouguer Gravity contours.

The permeability of the rock between the wells is artificially enhanced by a process called hydraulic stimulation which creates multiple flow paths from well to well. Cold water is then pumped down the 'injection well' where it percolates through the rock mass and is subsequently recovered in 'production wells'. The superheated water is returned to the surface where the heat is recovered in a heat exchanger before the cooled water is again injected.

The HDR approach differs from 'conventional geothermal energy' which is harnessed in countries such as New Zealand, Iceland, the western USA, Italy and Japan. In conventional geothermal energy, the surface power plants are operated by naturally occurring steam and/or hot water. The latter is produced when meteoric waters encounter near-surface sources of heat. These heat sources are often magmatic in origin (e.g. the Kakkonda geothermal field in northern Japan) but they can also have other origins. For example, a small conventional geothermal power station operates at Birdsville in southwest Queensland attached to an artesian bore that is flowing water from the Great Artesian Basin at 98°C.

Conventional geothermal energy is a significant resource worldwide with an estimated 8000 MW installed in 2000 (Lund, 2000). HDR, on the other hand, is still in the Rand D phase and has yet to produce a single power station. However, the signs are good internationally for HDR with projects underway in France, Switzerland, El Salvadore, the US and Australia. The Geodynamics project in northeastern South Australia is arguably the largest in overall scope.

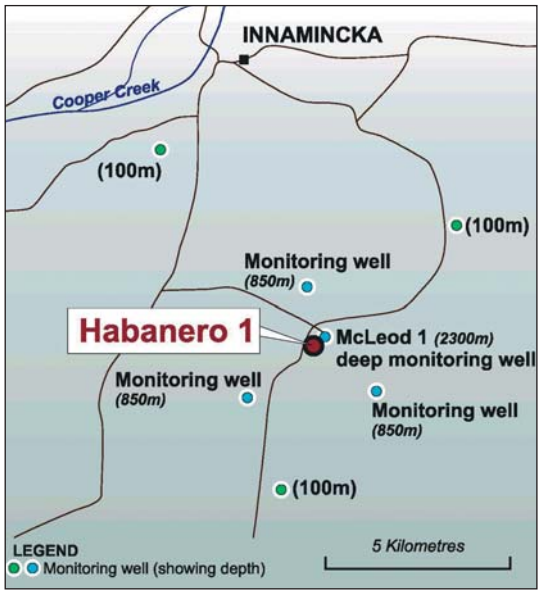

Fig. 4. Location of Habanero-1 well and the seismic monitoring stations.

In 2000 Primary Industry and Resources, South Australia (PIRSA) released three Geothermal Exploration Licences (GELs) for competitive tender under the new Petroleum Act (2000). Two of these, GEL97 and GEL98 in the Nappameri Trough, have been acquired by Geodynamics (Figure 3). The combined area of these two GELs is 1000 km2 and, as indicated in the figure, the estimated temperature at the bottom of the sediments is >200°C throughout the area.

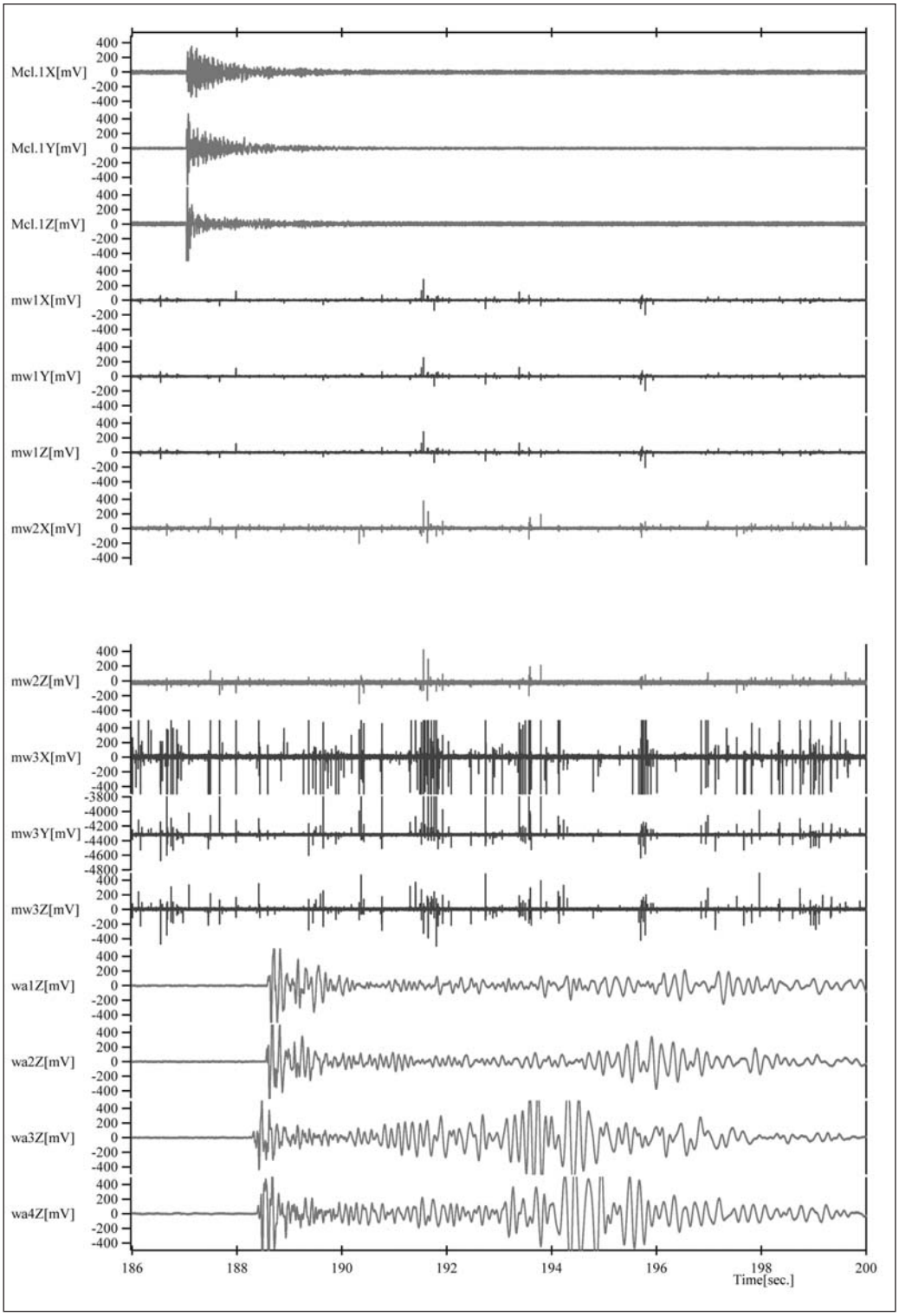

Fig. 5. Seismograms of seismic event originating from close to Habanero-1.

The new Habanero-1 well and the nearby older McLeod-1 well are currently the centre of Geodynamics' field program (Figure 4). Habanero-1 has been drilled and completed as an HDR injection well. The other wells shown in the figure serve as monitoring wells and each contains a micro-seismic detector. Three component geophones are set at 1700 m in McLeod 1, at 850 m in MW1, 2 and 3, and at ~100 m in WA1-4.

With drilling now complete and the micro-seismic monitors in place, the next step of the project is hydraulic stimulation. In this phase, which is currently underway, water is injected into Habanero-1 under high pressure. The water accesses existing joints and fractures and facilitates shear slip driven by the in-situ stress state in the granite. This shearing produces micro-seismicity that is being detected by the monitoring network. An example (see Figure 5) shows the signal recorded by the 3-component sondes in McLeod-1 and the wide area network for an event estimated in the range Magnitude -2 to -1. Note the P arrivals, the often well defined arrivals of S and the apparent polarisation of the latter in these preliminary results.

The schedule for the current hydraulic stimulation calls for 20,000 m3 of water to be injected over a period of several weeks into the 183 m open hole section of Habanero-1. At the same time, seismic monitoring is being used to locate micro-seismic events in near-real-time. To date >3000 events have been located in 3D space. At the end of the stimulation, the final 3D map of micro-seismicity will be used to locate a suitable site for the drilling of a second deep well. This well will be designed and completed as a production well with a casing and cementing program appropriate for the production of superheated water to the surface.

The final part of Phase 1 of the Geodynamics' plan will see a circulation test performed between the two wells with heat extracted at the surface through a heat exchanger. This is scheduled to commence in late 2004.

More details on the HDR project can be found at http://www.geodynamics.com.au and http://hotrock.anu.edu.au

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CSIRO Exploration and Mining: a briefing from the Chief of Division

As was reported in the August Preview, CSIRO's Division of Exploration and Mining is being restructured. This follows feedback from its industry clients and also a cut of 9.6% in funding, because it is not part of one of CSIRO's Flagship Programs. The Chief of the Division, Neil Phillips, has provided an update on the restructuring and the new directions planned for Division.

"CSIRO Exploration and Mining has undergone a significant restructuring and refocussing of its exploration research. These notes highlight some of the key features and directions of the changes, and how they will impact on a variety of stakeholders. The future of some areas of research and analytical facilities are still being decided in consultation with key partners.

The changes have been made after extensive input from industry and R&D partners, and in this regard, the Biennial AMIRA Exploration Managers' meeting was a particularly useful forum to gain a cross-section of industry ideas. Other influential input has included the Government's National Research Priorities, Prosser Inquiry, Mineral Exploration Action Agenda, National Committee of Earth Sciences and CSIRO's own Mineral Resources Sector Advisory Council chaired by Andrew Michelmore.

The change will allow CSIRO to address several key issues that have been consistently highlighted by its stakeholders:

- Move closer to the exploration 'market';
- Re-establish the long-term financial viability of CSIRO's mineral exploration-related activities; and
- Focus and consolidate key science capabilities.

Consolidation of its science will be through geographic focus such as:

- Geophysics and geoinformatics at the Australian Resources Research Centre in Perth (UWA, Curtin, CSIRO, industry);
- Geochemistry at Clayton (VIEPS, Synchrotron facility, other CSIRO Divisions) and exploration geochemistry at ARRC.

As a result of these changes, there will be a significantly reduced presence at North Ryde (Sydney) with the intention of closing CSIRO Exploration and Mining's activities there over time. Work on hyperspectral mineral mapping technologies and electro-magnetic modelling will continue in Sydney for the present, but future expansion in these areas will occur at ARRC (Perth), and possibly QCAT (Brisbane).

CSIRO Exploration and Mining's science portfolio focuses on four exploration themes:

Theme 1: Where to explore
Provide data, interpretative tools, and terrane scale geological information necessary for effective target area selection for key commodities in Australia.

Theme 2: Recognising ore systems
Provide geological criteria to differentiate significant ore deposits from minor occurrences and complex background signatures.

Theme 3: Exploring through cover
Enable the discovery of weathered and/or covered ore deposits in Australia.

Theme 4: Knowing what to mine
Cost-effective tools and strategies to convert resources to mineable reserves.

Much of the work in Theme 2 and Theme 3 is currently undertaken within pmd*CRC and CRC-LEME, respectively. Both of these CRCs remain critical to the Division's science program and address important industry issues.

However, as both the Action Agenda and Parliamentary Inquiry have highlighted, the current level of R&D expenditure is unlikely to arrest the decline in exploration or maintain a 'pipeline' of new ore bodies for development. As a result, there is support from industry for strategic 'blue sky' research. The Division is planning a series of new research programs, in research Themes 1 and 3 in particular, with a view to developing new frontier exploration opportunities and tackling the uniqueness of the Australian landscape through technologies to open up new parts of the Australian continent, particularly where there is relatively shallow cover.

The Division's new leaders:

- Brent McInnes (Terrane studies)
- Paul Roberts (Recognising ore systems)
- David Gray (Regolith exploration geoscience)
- Ernst Kohler (Exploring under cover)
- Lew Whitbourn (Detection technologies)
- Mark Berry (Mining geoscience)

Through these changes, CSIRO expects to be increasing its focussed exploration science research in the areas pertinent to:

- Nickel (Stephen Barnes)
- Gold (Ernst Kohler)
- Zinc (Timothy McConachy)"

The composition and extent of the research programs outside of the LEME and pmd*CRCs is yet to be announced but with such a significant cut in funding, the opportunities will have to be chosen very carefully.

Strong $A fails to dampen mini-resources boom

A strong Australian dollar may eventually dampen our resource industries, but for the moment this does not seem to be the case. The growth of the Chinese economy and the demand for gold and petroleum, because of uncertainty in the Middle East, are strong drivers for much of the Australian resources sector.

Gold looks good

A quick look at the Australian gold production and the price of gold over the last 18 years shows that in terms of Australian dollars we have generated considerable wealth over this period. Figure 1 shows the price of gold in $US and $A, for quarterly averages. In US dollars, the trend has been a steady decline in the last 15 years, but in terms of $A the reverse is true. The only real concern is that our annual gold production appears to be in decline, so there is a huge incentive to get smart and find new deposits.

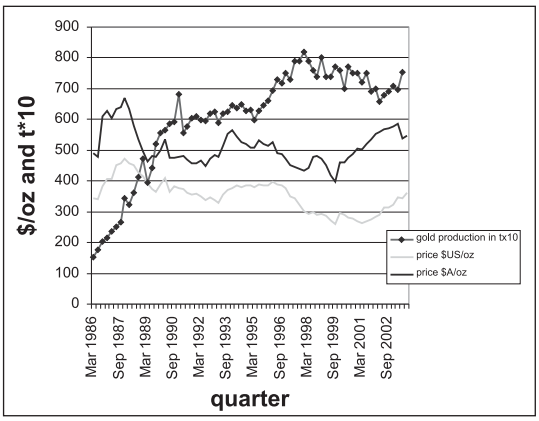

Fig.1. Quarterly Australian gold production in tonnes x 10 and price of gold averaged of quarters in $US and $A.

Petroleum may be even better

Bass Strait

In the petroleum sector the news is also good. In the Bass Strait Gippsland Basin ExxonMobil and BHP Billiton plan to start the largest exploratory drilling program for almost two decades in 2004. The program will extend over 18 months and will focus on a whole range of drilling targets identified by the recent 3D seismic survey conducted in the northern margins of the Bass Strait. Exploration for petroleum in Victoria increased from $85.1M in 2001/02 to $137.5M in 2002/03. The new drilling program will ensure that this trend continues.

Barrow Island

Meanwhile in Western Australia the Parliament has approved the Gorgon gas development, paving the way for a massive expansion in WA's LNG industry. Parliamentary approval was secured with the passage of the Barrow Island Bill 2003 through the Legislative Council, which saw the ratification of the Gorgon State Agreement. The approval gives the venture access to 300 hectares, or 1.3%, of Barrow Island.

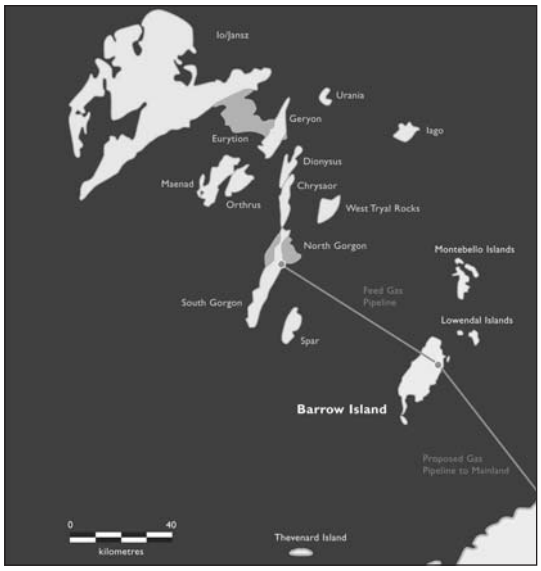

Fig. 2. Location diagram for Gorgon development from: http://www.gorgon.com.au/news/brochures/summary.pdf

The Gorgon area gas fields are located offshore, approximately 60 km from Barrow Island and approximately 200 km west of Dampier, on the Australian mainland. Five fields have so far been discovered - Gorgon, Chrysaor, Dionysus, West Tryal Rocks and Spar. Collectively called Greater Gorgon, these fields have been extensively appraised, including the eight wells in Gorgon itself. The field is being developed by CTMS, a consortium of Chevron, Texaco, Mobil and Shell. See Figure 2 for the location of the facility.

Up to 13.8 Tcf of hydrocarbon reserves have been certified as proven in the Greater Gorgon area. This includes 9.6 Tcf of proven hydrocarbon reserves in the Gorgon Field itself - enough for a two-train LNG Project. Proven plus probable reserves in the Greater Gorgon area therefore exceed 17.6 Tcf, with certified possible reserves increasing that total to 21.5 Tcf. The proven reserves in the Greater Gorgon area are the energy equivalent of a 2.25 Bbbl oil field.

3D seismic has been completed for all fields, and the above estimates have been based on the resulting reservoir-simulation models.

The Gorgon Venture gas project involves the construction of a gas processing plant on Barrow Island off the Pilbara coast to develop Australia's largest gas reserve. The development could become the largest industrial project ever for Australia amounting to an investment of about $11 billion.
Sub-sea technology and a special corrosion-resistant pipeline will be used to bring gas 70 km from the Gorgon Field to environmentally sensitive Barrow Island.

It could also give Australia $17 billion in taxes and royalties over the life of the development and generate extra export income of $2.5 billion a year. Under the 60-year agreement, the Gorgon Venture would be required to

set aside a minimum 2000 pJ of gas for domestic consumption.

ChevronTexaco Australia Managing Director, Jay Johnson, said a final investment decision would be made in mid-2005, with first gas expected in 2008.

Record high for iron ore production in 2002

World production of iron ore reached a record high of just over 1000 Mt in 2002, according to a new report from UK market analyst Roskill.

This results from the huge and largely unexpected growth in steel production and consumption in China since the start of the decade. The tonnage growth in China's steel output since 2000 is roughly equivalent to annual production in the USA. Although China has a very large iron ore industry, its output has long been insufficient to meet domestic demand and the country is heavily dependent upon imports, which doubled to 112Mt between 1999 and 2002 and were 44% higher in the first quarter of 2003 than in the same period the previous year. Although iron ore producers are moving to bring new capacity on-stream, the supply situation is likely to remain tight for the next two or three years, and an estimated 100 Mt/y of new capacity is required in the fairly short term. Worldwide some 190-200 Mt/y of production capacity is in the pipeline, most of it in Australia and Brazil. Between 2003 and 2005 up to 115 Mt/y will be brought into production, most of it towards the end of the period.

Whether the increased demand for iron ore in China will continue remains to be seen, but in the short term it should be good for Rio Tinto and BHP Billiton.

Recent years have seen a spate of merger and acquisition activity that has concentrated much of the world's iron ore production capacity in the hands of a very few corporate groups. Brazil's CVRD now has control over an estimated 95% of Brazil's iron ore production and all of its pellet capacity. Together with Rio Tinto and Billiton these three dominate the industry, with 30% of world iron ore production and 70% global exports.

In Australia Rio Tinto, which already owned the iron ore giant Hamersley, became the world's second largest producer in 2000 when it gained control over Robe River Iron Associates.

Resource shares keep climbing

The resource stocks on the ASX have also been climbing during the last three years. Figure 3 shows a plot of the total market capital of the resource companies, listed in the largest 150 companies on the ASX, the All Ordinaries index and the plot of BHP Billiton, which is the largest of the resource companies. Part of the increase is due to the listing of Placer Dome and Newmont in recent years. However, there can be no doubt about the upward trend in the data.

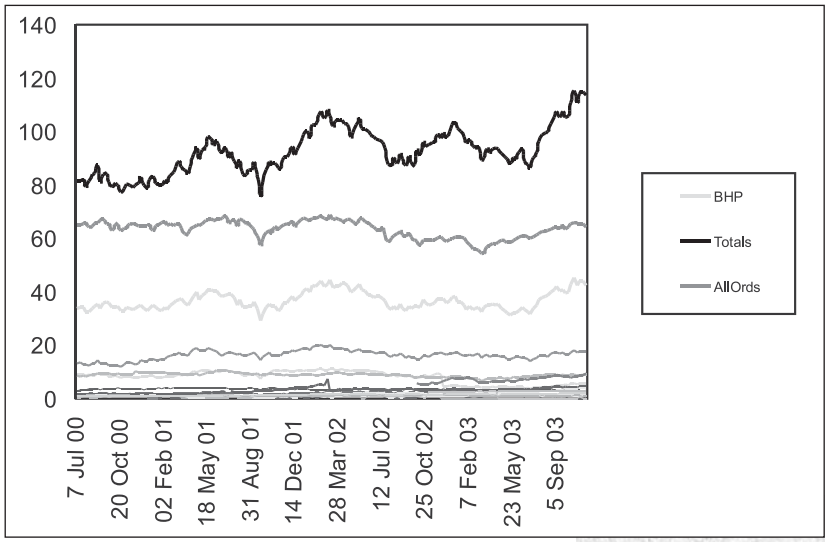

Fig. 3. Plot showing 1) The total market capital of resource stocks listed on the ASX from the top 150 companies, in $billions; 2) The All Ords. index x 10; and the market capital of BHP Billiton (the largest resource company) in $billions. The lower plots are from the smaller companies including Rio Tinto, Woodside, Placer Dome etc.

Placer Dome produces record gold result

For the first time in Placer Dome's history the company's quarterly gold production exceeded one million ounces, totalling 1,014,172 ounces (~31.5 t). The record-breaking production was primarily due to contributions from the North Mara mine in Tanzania and better than expected performance at 13 properties.

During the quarter mine operating earnings and cash flow from operations also increased 725 and 116% respectively over the previous quarter, totalling $112 million and $125 million in the third quarter.

Looking ahead, Placer Dome President and CEO, Jay Taylo,r said, "the company would continue to advance its exploration and development properties to increase shareholder value.

"Our exploration activities are primarily focused in and around existing mine sites. We are drilling and evaluating new deposits at several properties, including Cortez, Granny Smith, Campbell, and La Coipa. At the same time, we are evaluating promising new targets in eastern Canada, Nevada, and elsewhere."

A very good result.

Austpac to build new synthetic rutile plant

Austpac, a small high-tech company founded in 1986 can at last see its way clear to transforming ilmenite into high grade synthetic rutile, a preferred feedstock for titanium dioxide pigment production. In a recent agreement, Iluka Resources will provide Austpac with ilmenite feedstock and

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Geophysical Inverse Theory and Regularisation Problems

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Geophysical Inverse Theory and Regularisation Problems provides a comprehensive and unified description of the application of Tikhonov regularisation to modern geophysical inverse problems. Detailed mathematical terminology is used to familiarise the reader with a suite of tools and techniques that can be used to solve complex ill-posed inverse problems without shying away from explaining why these tools work. The book is separated into five parts. Part I provides an introduction to inversion, describing the important concept of the ill-posed problem. Part II details a number of different inversion methods and sets the context for the remainder of the book. Parts III, IV and V describe the application of regularisation to geopotential fields, electromagnetic and seismic inverse problems respectively.

It has been a century since David Hilbert, arguably one of the most influential contemporary mathematicians, gave his famous speech to the International Congress of Mathematicians in Paris that lead, among other things, to the development of the field of functional analysis and the notion of a Hilbert Space. Part I introduces geophysical inversion by describing its representation in a Hilbert Space and discussing relevant results from functional analysis. The notion of a solutions existence, its uniqueness, instability, noise and ill-posed inverse problem are all introduced. Most notably, Part I describes the conversion of an ill-posed inverse problem to a well-posed problem using Tikhonov regularisation. Part I concludes by describing a suite of different stabilising functionals for use with Tikhonov regularisation and it introduces techniques for finding the optimal regularisation parameter.

By representing the stabilizing functional in a 'pseudo quadratic' form, Zhdanov is able to present a unified approach to regularisation. This is achieved in Part II by discussing the 'linear discrete inverse problem', 'iterative solutions of the linear inverse problem' and the 'nonlinear inversion technique'. Detailed descriptions of several regularisation algorithms are provided. Part II also presents a good explanation of the use of model weights to reduce the influence of model parameters that would otherwise dominate an inversion.

Parts III, IV and V show how regularisation can be used to solve common problems in geopotential field, electromagnetic and seismic problems respectively. Each of these parts includes a general description of the relevant geophysical theory, an explanation of how the various geophysical fields can be reduced to integral representations of a forward model and they describe how regularisation can be used to solve the inverse problem. Part IV, the section focussing on Electromagnetic Inversion, also describes how electromagnetic inverse problems can be discretised and solved directly from Maxwell's equations without resorting to an integral representation.

Geophysical Inverse Theory and Regularisation Problems is an impressive book that I have no hesitation recommending to any science or mathematics graduates with an interest in mathematical geophysics. The book would be of particular interest to graduate students and researchers. Unfortunately the highly specific nature of the book and economies of scale means that it may be outside the price range of many would be readers. However, if you are interested in geophysical inversion it is well worth a look.

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at the same time buy the 30,000 t/y of finished synthetic rutile. Austpac has been exploring for mineral sands in the Murray Basin for several years but these leases are not producing the required quantity or quality of ilmenite.

Australia's Mining Technology Services sector plans to double its business by 2010

Australia's mining technology services (MTS) sector is already a world leader in providing innovative and highly technical products and services to both the domestic and, increasingly, to the global minerals industry.

It was estimated to be worth over $3 billion to Australia in 2000-01 and the sector's potential for growth is greatest in terms of exports.

The MTS sector has set the goal of increasing export sales to $6 billion by 2010 through the implementation of the recommendations contained in the national Mining Technology Services Action Agenda. Those involved in the Action Agenda reported in July this year and Ian Macfarlane the Minister for Industry, Tourism and Resources has appointed an Implementation Group to ensure that action is taken on the six main recommendations in the report.

These recommendations include unifying the sector, innovation through technology, attracting investment, embracing e-business for growth, retaining skilled staff and protecting intellectual property. $6 billion is a substantial amount by any standard and we wish the sector well in achieving this growth.